HP 8722A/C
NETWORK ANALYZER

SERVICE MANUAL

SERIAL NUMBERS

This manual applies directly to all HP 8722A/C Network Analyzers.

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1400 FOUNTAINGROVE PARKWAY, SANTA ROSA, CA 95403 U.S.A.

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HEWLETT PACKARD

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power, cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer make sure the common terminal is connected to the neutral (grounded side of the mains supply).

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged even when disconnected from their power source.

To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

COMPLIANCE WITH GERMAN FTZ EMISSIONS REQUIREMENTS

This Network Analyzer complies with German FTZ 526/527 Radiated Emissions and Conducted Emissions requirements.

COMPLIANCE WITH GERMAN NOISE REQUIREMENTS

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung –3. GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission	
LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal operation	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name:	Hewlett–Packard Company
Manufacturer's Address:	Network Measurements Division 1400 Fountaingrove Parkway Santa Rosa, California 95403 U.S.A.

declares that the product

Product Name:	Vector Network Analyzer
Model Number:	HP 8722A/C*
Product Options:	All options

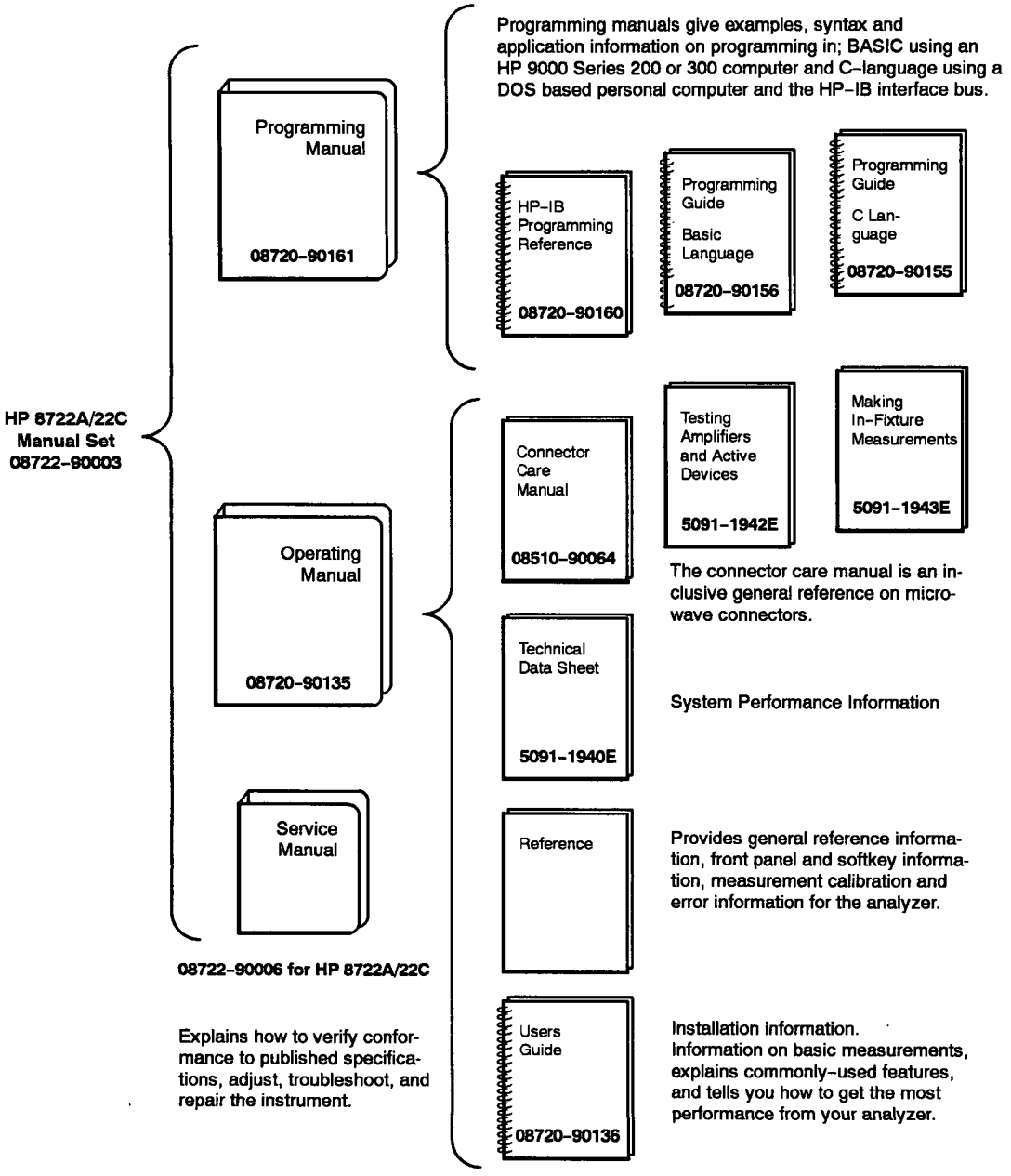
conforms to the following Product Specifications:

Safety:	IEC 348
EMC:	EN55011 Class A/CISPR–11 class A EN50082–1/2–1991 IEC 801–2/1991 4kV CD, 8kV AD IEC 801–3/1984 3V/m (26–500 MHz) IEC 801–4/1988 500V

*The HP 8722A/C was qualified as part of a product family, including the HP 8719C, HP 8720C, and the HP 8722A/C.

Santa Rosa	10/28/92	Dixon Browder, Quality Manager
(Location)	(Date)	

HP 8722 Documentation Map


HP 8722A/22C
Manual Set
08722-90003
Programming Manual
08720-90161
Programming manuals give examples, syntax and application information on programming in; BASIC using an HP 9000 Series 200 or 300 computer and C-language using a DOS based personal computer and the HP-IB interface bus.
HP-IB Programming Reference
08720-90160
Programming Guide
Basic Language
08720-90156
Programming Guide
C Language
08720-90155
Operating Manual
08720-90135
Connector Care Manual
08510-90064
Testing Amplifiers and Active Devices
5091-1942E
Making In-Fixture Measurements
5091-1943E
The connector care manual is an inclusive general reference on microwave connectors.
Technical Data Sheet
5091-1940E
System Performance Information
Service Manual
08722-90006 for HP 8722A/22C
Explains how to verify conformance to published specifications, adjust, troubleshoot, and repair the instrument.
Reference
Provides general reference information, front panel and softkey information, measurement calibration and error information for the analyzer.
Users Guide
08720-90136
Installation information.
Information on basic measurements, explains commonly-used features, and tells you how to get the most performance from your analyzer.

CONTENTS

HP 8722A/C NETWORK ANALYZER
SERVICE MANUAL

CONTENTS

Chapter 1. Service and Equipment Overview

ORGANIZATION OF SERVICE MANUAL 1–1
TABLE OF SERVICE TEST EQUIPMENT 1–3

Chapter 2. Preventive Maintenance

CHECK THE FRONT PANEL CONNECTORS 2–1
CHECK THE ERROR TERMS 2–1
Perform a Full 2–Port Calibration 2–2
Plot the Error Terms 2–2
CLEAN THE FAN FILTER 2–3
CLEAN THE GLASS FILTER (AND CRT AS REQUIRED) 2–4

Chapter 3. Specifications

Specifications 3–1
UNCORRECTED PERFORMANCE 3–2
SOURCE SPECIFICATIONS 3–3
SOURCE FREQUENCY SPECIFICATIONS 3–3
SOURCE POWER SPECIFICATIONS (23°± 3°C) 3–4
GENERAL CHARACTERISTICS 3–5
MEASUREMENT THROUGHPUT SUMMARY 3–5
REAR PANEL CONNECTORS 3–6
EFFECT OF FREQUENCY RESOLUTION 3–7
Supplemental Characteristics 3–8
2.4 MM SYSTEM SPECIFICATIONS 3–9
DEVICES WITH 2.4 MM CONNECTORS 3–9
Measurement Uncertainty: HP 85056A Calibration Kit 3–9
Measurement Uncertainty: HP 85056D Calibration Kit 3–18
3.5 MM SYSTEM SPECIFICATIONS 3–27
DEVICES WITH 3.5 MM CONNECTORS 3–27
Measurement Uncertainty: HP 85052D Calibration Kit 3–27
Measurement Uncertainty: HP 85052B Calibration Kit 3–36
7 MM SYSTEM SPECIFICATIONS 3–45
DEVICES WITH 7 MM CONNECTORS 3–45
Measurement Uncertainty: HP 85050D Calibration Kit 3–45
Measurement Uncertainty: 85050B Calibration Kit 3–54
TYPE–N SYSTEM SPECIFICATIONS 3–63

DEVICES WITH TYPE–N CONNECTORS 3–63
Measurement Uncertainty: HP 85054D Calibration Kit 3–63
Measurement Uncertainty: HP 85054B Calibration Kit 3–72
2.92 MM SYSTEM CHARACTERISTICS 3–81
DEVICES WITH 2.92 MM CONNECTORS (K CONNECTOR) 3–81
Measurement Uncertainty: HP 85056K Calibration Kit 3–81

Chapter 4. Verification

SYSTEM PERFORMANCE 4–1
Individual System Components 4–2
Calibration Kit 4–2
Measurement Process 4–2
Measurement Errors 4–3
SYSTEM PERFORMANCE VERIFICATION 4–3
OPERATIONAL CHECK PROCEDURES 4–5
ENVIRONMENT AND DEVICE TEMPERATURE CHECK 4–5
INSPECT, CLEAN, AND GAGE CONNECTORS 4–5
CABLE CHECK 4–6
Return Loss of Cables 4–6
Insertion Loss of Cables 4–7
Magnitude and Phase Stability of Cables 4–8
Cable Connector Repeatability 4–9
POWER LEVEL CHECK 4–11
Dynamic Range check 4–13
OPERATOR'S CHECK 4–15
PERFORMANCE TESTS 4–18
PERFORMANCE TEST TOOLS 4–18
CALIBRATION CYCLE (PERFORMANCE VERIFICATION) 4–18
IF THE INSTRUMENT FAILS A TEST 4–18
Frequency Range and Accuracy Performance Test 4–19
TOTAL SYSTEM UNCERTAINTY TEST PROCEDURE 4–20
VERIFICATION KIT 4–20
SYSTEM VERIFICATION CYCLE AND KIT RE–CERTIFICATION 4–20
MEASUREMENT UNCERTAINTY 4–20
MEASUREMENT TRACEABILITY 4–21
Cable Substitution 4–23
Calibration Kit Substitution 4–23
CALIBRATION CYCLE 4–24
Initialization 4–24
Measurement Calibration 4–26
System Verification 4–27
Connecting Device 4–28
IN CASE OF FAILURE 4–29
If the System Fails the Total System Uncertainty Test 4–30

Connecting the Airlines 4-32
COMPARING SYSTEM MEASUREMENT UNCERTAINTIES FOR THE PERFORMANCE VERIFICATION DEVICES 4-35
How to Interpret the Verification Results 4-38
MEASUREMENT UNCERTAINTIES 4-40
SOURCES OF MEASUREMENT ERRORS 4-40
Sources of Systematic Errors 4-40
Sources of Random Errors 4-41
Sources of Drift Errors 4-42
Sources of Additional Measurement Errors 4-42
MEASUREMENT UNCERTAINTY EQUATIONS 4-42
Reflection Uncertainty Equations 4-43
Total Reflection Magnitude Uncertainty (Erm) 4-43
Reflection Phase Uncertainty (Erp) 4-44
Transmission Uncertainty Equations 4-44
Transmission Magnitude Uncertainty (Etm) 4-44
Transmission Phase Uncertainty (Etp) 4-45
DYNAMIC ACCURACY 4-45
DETERMINING EXPECTED SYSTEM PERFORMANCE 4-46
Procedures 4-47
TOTAL SYSTEM PERFORMANCE TEST RECORD 4-54
TOTAL SYSTEM PERFORMANCE TEST RECORD OPTION 003 4-56
TOTAL SYSTEM PERFORMANCE TEST RECORD HP 8722C OPTION 006 4-58

Chapter 5. Adjustments

ORDER OF ADJUSTMENTS 5-1
TEST EQUIPMENT 5-2
INSTRUMENT COVER REMOVAL 5-2
A9 CC (CORRECTION CONSTANT) JUMPER POSITION 5-2
A9 CC JUMPER POSITION PROCEDURE 5-3
DISPLAY POSITION AND FOCUS ADJUSTMENTS 5-4
Vertical Position Adjustment 5-4
Focus Adjustment 5-5
DISPLAY DEGAUSSING (DEMAGNETIZING) 5-6
DISPLAY INTENSITY ADJUSTMENTS 5-7
Background Adjustment 5-7
Maximum Intensity Adjustment 5-8
Operating Default Intensity Adjustment 5-9
SERIAL NUMBER CORRECTION CONSTANT 5-10
OPTION NUMBERS CORRECTION CONSTANT 5-11
ANALOG BUS CORRECTION CONSTANTS 5-13
IF AMPLIFIER CORRECTION CONSTANTS 5-14
ADC LINEARITY CORRECTION CONSTANTS 5-15

SOURCE PRETUNE CORRECTION CONSTANTS 5-16
EEPROM BACKUP DISK PROCEDURE 5-17
How to Make an EEPROM Backup Disk and Store Correction Constant Data to It 5-17
How to Retrieve Correction Constant Data from the EEPROM Backup Disk 5-18
REFERENCE ASSEMBLY VCO TUNE ADJUSTMENT 5-19
FREQUENCY ACCURACY ADJUSTMENT 5-21
SAMPLER CHECK 5-22
A Sampler Check 5-22
B Sampler Check 5-22
R Sampler Check 5-23
POWER ADJUSTMENTS 5-24
LOW BAND POWER LEVEL ADJUSTMENT 5-25
BLANKING ADJUSTMENT 5-26
POWER LINEARITY CORRECTION CONSTANTS 5-27
CAL KIT DEFAULTS CORRECTION CONSTANTS 5-28

Chapter 6. Troubleshooting (and Block Diagram)

INITIAL OBSERVATIONS 6-1
TROUBLESHOOTING HP-IB SYSTEMS 6-3
Troubleshooting Systems with Multiple Peripherals 6-3
Troubleshooting Systems with Controllers 6-4

Chapter 7. Isolate Faulty Group

POWER SUPPLY 7-1
DIGITAL CONTROL 7-2
SOURCE 7-2
RECEIVER 7-3
ACCESSORIES 7-3
ISOLATE FAULTY GROUP WORKSHEET (1 of 2) 7-5

Chapter 8. Power Supply

LED State Definitions 8-1
Fan 8-3
Power Supply Error Messages 8-3
CHECK A15 PREREGULATOR AND LOADS 8-3
Check A15 Green LED on Rear Panel 8-3
Disconnect A15W1 and Check Red LED 8-4
Check A15 and +5V Loads 8-4
Remove A51 Loads 8-5
Check A15W1 Voltages 8-5
CHECK A8 POST-REGULATOR AND LOADS 8-6
Check Fan 8-6
Check Display 8-6

Check Assemblies Loading +7.5V Supply 8–7
A8 LEDs ARE NOT ALL ON 8–7
Check A8 Alone 8–7
Check Upper Box Assemblies 8–7
Check Lower Box Assemblies 8–7
Check the Display 8–8
Check the Remaining Loads and Traces 8–8
FAN TROUBLESHOOTING 8–8
Measure A8 Fan Voltages 8–8
Measure A15 Fan Voltages 8–9
DISPLAY POWER TROUBLESHOOTING 8–9
Verify A8 Display Voltages 8–9
TEST POINT VOLTAGES 8–10
In Case Of Difficulty 8–10

Chapter 9. Digital Control

Abus Test Failure 9–1
Fatal Errors 9–1
HP–IB Failures 9–1
PRELIMINARY CHECKS 9–1
A9 CPU CHECK 9–2
DISPLAY CHECK 9–2
FRONT PANEL CONTROL CHECK 9–3
DIAGNOSTIC CHECKS 9–3
FATAL ERROR TROUBLESHOOTING 9–5
DISPLAY TROUBLESHOOTING 9–5
Measure Display Power Supply Voltages Entering A19 9–5
Display Power Supply Troubleshooting 9–6
Run Display Test 55 9–7
Inspect Ribbon Cable and Repeat Display Test 55 9–7
Perform CPU – GSP Communication 9–7
Run Remaining Display Tests 9–8
HP–IB TROUBLESHOOTING 9–9
A1/A2 FRONT PANEL TROUBLESHOOTING 9–9
No Front Panel Control 9–9
Stuck Key 9–10

Chapter 10. Source

Phase Lock Error Message Displayed 10–1
Power Not Within Specifications 10–3
BROADBAND PHASE LOCK PROBLEMS 10–4
Swap Samplers to Check A64 R Sampler 10–4
Check Open Loop Power 10–4
Check A12 Reference 10–5

Check A14 Fractional–N 10–5
A14 VCO Range Check with Oscilloscope 10–6
A14 VCO Exercise 10–7
A14 Divide–by–N Circuit Check 10–8
A14–to–A13 Digital Control Signals Check 10–8
A52 Pulse Generator Check 10–9
BAND–RELATED PROBLEMS 10–10
BROADBAND POWER PROBLEMS 10–11
ALC/Signal Separation Check 10–11
A69 Step Attenuator Check 10–12
A51 INTERFACE POWER SUPPLIES 10–12
Measuring Lower Box Bias Voltages 10–12

Chapter 11. Receiver

ALL SIGNAL PATHS LOOK ABNORMAL 11–1
2nd LO Check 11–1
4 MHz Check 11–2
AT LEAST ONE SIGNAL PATH LOOKS NORMAL 11–2
Directional Coupler Check 11–3
A and B Sampler Check by Substitution 11–4
Sampler Voltage Check 11–4
2nd Converter Check 11–5

Chapter 12. Accessories

INSPECT AND GAUGE CONNECTORS 12–1
SWITCH REPEATABILITY 12–2
INSPECT ERROR TERMS 12–3
Isolate the Fault in the RF Path 12–4
Cable Test 12–6
Verify Shorts and Opens 12–6

Chapter 13. Service Key Menus

INTERNAL DIAGNOSTICS SUMMARY 13–1
TESTS MENU 13–2
TEST OPTIONS MENU 13–3
SELF DIAGNOSE SOFTKEY 13–4
TEST DESCRIPTIONS 13–4
Internal Tests 13–4
External Tests 13–6
Sys Ver Tests 13–6
Adjustment Tests 13–7
Display Tests 13–8
Test Patterns 13–8
SERVICE MODES SUMMARY 13–9

SERVICE MODES MENU 13–11
SERVICE MODES MORE MENU 13–12
SRC TUNE MENU 13–12
ALC ON OFF SOFTKEY 13–13
PEEK/POKE MENU 13–13
FIRMWARE REVISION SOFTKEY 13–13
INPUT PORTS MENU 13–14
ANALOG BUS MENU 13–15
DESCRIPTION OF THE ANALOG BUS 13–15
The Main ADC 13–16
The Frequency Counter 13–16
Notes 13–16
ANALOG BUS NODES 13–16
A10 Digital IF 13–16
A11 Phase Lock 13–17
A12 Reference 13–20
A14 Fractional–N (Digital) 13–21
HP–IB SERVICE MNEMONIC DEFINITIONS 13–22
Invoking Tests Remotely 13–22
Symbol Conventions 13–23
Analog Bus Codes 13–23
ROM/RAM TESTS 13–24

Chapter 14. Error Terms

MEASUREMENT CALIBRATION PROCEDURE 14–2
ERROR TERM INSPECTION 14–3
Hardcopy Procedure 14–4
ERROR TERM DESCRIPTIONS 14–4
Directivity (EDF and EDR) 14–5
Source Match (ESF and ESR) 14–6
Reflection Tracking (ERF and ERR) 14–7
Isolation (Crosstalk, EXF and EXR) 14–8
Load Match (ELF and ELR) 14–9
Transmission Tracking (ETF and ETR) 14–10

Chapter 15. Theory of Operation

SYSTEM OPERATION 15–1
FUNCTIONAL GROUPS OF THE ANALYZER 15–2
POWER SUPPLY THEORY 15–3
A15 Preregulator 15–3
A8 Post–Regulator 15–4
DIGITAL CONTROL THEORY 15–5
A1 Front Panel 15–7
A2 Front Panel Processor 15–7

A9 CPU 15–7
Color Display 15–8
A16 Rear Panel 15–8
A51 Test Set Interface 15–8
SOURCE GROUP THEORY 15–9
1. Source Pretune 15–10
2. A14/A13 Fractional–N Synthesizer 15–10
3. A52 Pulse Generator: the Harmonic Comb 15–10
4. A64 R Sampler: Down–Converting the Signals 15–10
5. A11 Phase Lock: Comparing Phase and Frequency 15–11
6. Tuning the YIG Oscillator 15–11
7. Phase Locked Sweep 15–11
A12 Reference: the Crystal Reference Frequencies 15–12
Source Block: The YIG Oscillator Signals 15–12
ALC: Automatic Leveling Control 15–14
SIGNAL SEPARATION 15–14
A58 M/D/S Modulator, Detector, Splitter 15–14
A69 Step Attenuator 15–15
S4 Transfer Switch 15–15
A56 Lower Front Panel Assembly 15–15
A60 and A61 DC Bias Tees 15–15
A62 and A63 Directional Couplers 15–15
RECEIVER THEORY 15–15
Samplers and Second Converters 15–16
A10 Digital IF 15–17

Chapter 16. Replaceable Parts

ADJUSTMENTS AND VERIFICATION 16–1
R–E (REBUILT–EXCHANGE) ASSEMBLIES COST LESS 16–1
REPLACEABLE PARTS LIST 16–1
ORDERING INFORMATION 16–2
How to Order Parts ... Fast! 16–2

Chapter 17. Replacement Procedures

ADJUSTMENTS AND PERFORMANCE TESTS 17–1
COVER REMOVAL 17–1
A1/A2 FRONT PANEL AND
ROTARY PULSE GENERATOR REPLACEMENT 17–4
A18 DISPLAY REPLACEMENT 17–6
A16 REAR PANEL AND
A15 PREREGULATOR REPLACEMENT 17–8
To Remove the A16 Rear Panel Assembly 17–9
To Remove the Preregulator 17–9
A64/A65/A66 SAMPLER REPLACEMENT 17–12
To Remove the A or B Sampler 17–12

To Remove the R Sampler 17-12
J1/J2 TEST PORT CONNECTORS, A62/A63 DIRECTIONAL COUPLERS, AND A56 LOWER FRONT PANEL REPLACEMENT 17-15
To Remove the Test Port Connectors and Directional Couplers 17-15
A60/A61 BIAS TEES, A69 STEP ATTENUATOR, AND S4 TRANSFER SWITCH REPLACEMENT 17-18
To Remove the Bias Tees 17-18
To Remove the Transfer Switch 17-18
To Remove the Step Attenuator 17-18
A51 TEST SET INTERFACE REPLACEMENT 17-20
A53 LOW BAND REPLACEMENT 17-21
A58 M/D/S MICROCIRCUIT-HP 8722A A58 M/A/D/S MICROCIRCUIT-HP 8722C 17-23
A55 YIG 1 AND A54 YIG2 REPLACEMENT 17-26
S1/S2/S3 MICROWAVE SWITCH REPLACEMENT 17-27
A59 SOURCE INTERFACE REPLACEMENT 17-29
A52 PULSE GENERATOR REPLACEMENT 17-32

Chapter 18. Post-Repair Procedures

Chapter 19. Instrument History

SERVICE AND EQUIPMENT OVERVIEW

Chapter 1. Service and Equipment Overview

INTRODUCTION

This *Hewlett-Packard Service Manual* is a complete guide to servicing the HP 8722 microwave network analyzer alone or in a system. It is part of a three manual set, which also includes the *Operating Manual,* and the *Programming Manual.*

This manual contains information required to maintain, test, troubleshoot, and repair the analyzer. The rest of this section describes the organization of that information. This section also includes the *Table of Service Test Equipment*, which lists the equipment (and its critical specifications) required to monitor or adjust the instrument.

NOTE: In this manual, all front panel keys are shown as [SYSTEM]; softkey labels are shown as SERVICE MENU.

ORGANIZATION OF SERVICE MANUAL

Tabs are used to divide the major sections of this manual. The names of the tabs following this section, and the contents, are described below.

- *Preventive Maintenance* consists of routine tasks to be performed by the operator every six months or more often, to ensure that the instrument is maintained in good working condition.
- *Verification* consists of three parts.

  Operator's Check: a brief procedure that tests all circuits in the analyzer to verify with 80% confidence that the instrument is functioning properly. It does not verify conformance to specifications.

  Total system Uncertainty Test: a procedure designed to verify system-level error-corrected measurement performance. Known traceable standards are measured and compared with recorded data. This automated procedure is contained in firmware internal to the analyzer, and requires a disk drive.

  Performance Tests: step-by-step procedures that verify certain individual performance specifications of the network analyzer.
- *Adjustments* provides instructions for adjustment and alignment of the instrument after repair or replacement of an assembly. Some of the adjustments are semi-automated procedures for altering correction constants (non-mechanical adjustments). The tab itself illustrates how to remove the instrument covers and how to set the A9 CPU jumper.

NOTE: The eight, white–tabbed sections are the core troubleshooting sections.

- *Troubleshooting and Block Diagram*. The troubleshooting strategy is to systematically verify portions of the network analyzer, and thus narrow down the cause of a problem to the defective assembly. This section is the first of a series of troubleshooting procedures. It checks the operation of the network analyzer independent of system peripherals, and suggests how to remedy system problems. The tab also illustrates how to remove the instrument covers and how to set the A9 CPU jumper.

  The *Overall Block Diagram* concludes this section.

- *Isolate Faulty Group* is used after a problem has been shown to be in the network analyzer. This initial instrument troubleshooting section can be used equally productively on location or over the phone to isolate the fault to one of the five functional groups in the network analyzer.

- *Power Supply*
- *Digital Control*
- *Source*
- *Receiver*
- *Accessories*

Each of the first four functional group sections above verifies its constituent assemblies until the faulty assembly is identified. *Accessories* verifies external RF cables and calibration kit devices.

NOTE: the following sections are, for the most part, reference material.

- *Service Key Menus* documents the functions of the menus accessed from the **SERVICE** softkey. These menus let the operator test, verify, adjust, control and troubleshoot the analyzer. All of the internal tests and the 23 analog bus nodes are documented here. HP–IB service mnemonics are included.

- *Error Terms* can be powerful preventive maintenance and troubleshooting tools, besides being the basis for accuracy enhancement. This section documents the access and use of these internally–stored terms.

- *Theory of Operation* explains the overall operation of the instrument, the division into functional groups, and the operation of each functional group.

- *Replaceable Parts* provides part numbers and illustrations of the replaceable assemblies and miscellaneous chassis parts, together with ordering information.

- *Replacement Procedures* provides procedures to disassemble portions of the instrument when certain assemblies are to be replaced. Cover removal is illustrated on this tab.

- *Post–Repair Procedures* contains the *Table of Related Service Procedures*. It is a table of adjustments and verification procedures to be performed after repair or replacement of each assembly.

- *Instrument History* contains information required to make this manual compatible with earlier shipment configurations of the instrument.

TABLE OF SERVICE TEST EQUIPMENT

The first part of Table 1–1, *Service Test Equipment*, lists all of the equipment required to verify, adjust, and troubleshoot the analyzer and perform the operator's check. The table also notes the use and critical specifications of each item, and the recommended models.

The second part of the table is similar to the first but it relates specifically to one adjustment: the display adjustments for color CRTs.

Table 1–1. Service Test Equipment (1 of 2)

Instrument	Critical Specs	Recommended Model	Use
Frequency Counter	Freq:0.050 to 26.5 GHz Accuracy:3 ppm	HP 5351B	V,A,T
Spectrum Analyzer	Freq:100 Hz to 22 Ghz	HP 8566B, 8563E	V,A,T
Power Meter	Range:—30 to +15 dBm Accuracy:±0.05 dB	HP 436A, 438A, 437B*	V,A,T
Power Sensor	Freq:0.050 to 40 GHz Range:—30 to +20 dBm	HP 8487A	V,A,T
DVM	Resolution:10 mV	Any	A,T
Oscilloscope	Bandwidth:100 MHz	Any	T
Disk Drive	CS80 protocol	HP 9122C/D/S, 9153B, 9133A/H/L	V,A
Printer	Raster graphics capability	HP 2225A, 9876A, 2673A	V
HP–IB Cables		HP 10833A/B/C/D	V,A
RF Cable Set	2.4 mm connectors	HP 85133/D/E/F	V,A,T
Tool Kit	No substitute	08720–60004	A,T
2.4 mm Calibration Kit[1]	No substitute	HP 85056A/D	V,A,T,OC
2.4 mm Verification Kit[2]	No substitute	HP 85057B	V
* HP 437A or 438A is required for power meter calibration.			

1. Calibration can also be done in other connector types with these kits:

3.5 mm	HP 85052B/D
7 mm	HP 85050B/D
Type–N	HP 85054B/D

   Appropriate cables will be required (refer to *System Overview* in the *Operating Manual*).

2. Verification can also be done on the HP 8722C with the HP 85053B 3.5 APC to 26.5 GHz.

Table 1–1. Service Test Equipment (2 of 2)

The following equipment is needed only for Display Intensity Adjustments which apply to color CRTs.			
Instrument	**Critical Specs**	**Recommended Model**	**Use**
Photometer	No substitute	TEK J16 opt 2	A
Photometer Probe	No substitute	TEK J6503 opt 2	A
Light Occluder	No substitute	TEK 016–0305–00	A

Notes:

V = Verification (Total System Uncertainty Test)
A = Adjustments
T = Troubleshooting
OC = Operator's Check

Chapter 2. Preventive Maintenance

INTRODUCTION

Preventive maintenance consists of four tasks. It should be performed at least every six months—more often if the instrument is used daily on a production line or in a harsh environment. Error terms, for example, are more meaningful when checked more often but, again, instrument usage should be the criterion. The four tasks are to:

- Check the front panel connectors,
- Check the error terms,
- Clean the fan filter, and
- Clean the glass filter (and CRT as required).

CHECK THE FRONT PANEL CONNECTORS

Visually inspect the front panel connectors. They should be clean and the center pin centered. If so, gauge the connectors.

Mechanical characteristics such as center conductor protrusion and pin depth are not performance specifications. They are, however, important supplemental characteristics related to electrical performance.

Also inspect and gage the connectors of the calibration kit devices. Refer to the calibration kit manual for center pin recession limits.

If the connectors are dirty or damaged, refer to the *Microwave Connector Care* manual in the *Operating Manual*. That manual details connector care techniques including cleaning and gauging connectors, damage signs, making good connections, proper handling and storage.

CHECK THE ERROR TERMS

Error terms (E−terms or calibration coefficients) are an indication of the condition of the instrument, its calibration kits, and cables. When tracked over a period of time, error terms can signal and identify system component and performance degradation. Error term comparisons are best made with data generated periodically by the same instrument and cal kit (the kit normally used with the network analyzer). For this reason, generating error terms at the time of installation and at regular intervals thereafter is recommended.

A related recommendation is to establish a log book to store the error term plots and the results of the yearly verification.

Perform a Full 2–Port Calibration

To obtain hard copy error term plots, connect a printer or plotter to the analyzer via an HP–IB cable prior to turning on the instruments.

1. Turn on the instruments and press [RECALL] RECALL FAC PRESET. Then press [CAL] CALIBRATE MENU FULL 2–PORT REFLECT'N to begin the calibration.
2. Perform the following:
   b. Connect an open to port 1 and press (S11):OPEN
   c. Connect a short to port 1 and press (S11):SHORT.
   d. Either connect a broadband load to port 1 and press (S11):LOADS BROADBAND DONE: LOADS or

      Connect a sliding load to port 1 and press (S11):LOADS SLIDING. Set the slide and press SLIDE IS SET; reposition the slide and press SLIDE IS SET four more times. Then press SLIDING LOAD DONE. Connect the lowband load, press LOWBAND and then DONE: LOADS.
3. Repeat step 2 for S22 at port 2.
4. Press REFLECT'N DONE
5. When the cal coefficients have been calculated, press TRANSMISSION. Connect a single cable or cable pair, consistent with normal system use, between ports 1 and 2 and press DO BOTH FWD + REV.
6. Connect loads to ports 1 and 2 or the cables (consistent with normal system use). Press [AVG] IF BW [1] [0] [x1] to change the IF bandwidth to 10 Hz. Then press [CAL] RESUME CAL SEQUENCE ISOLATION DO BOTH FWD + REV, then press DONE 2–PORT CAL.

Plot the Error Terms

7. Press [DISPLAY] MORE TITLE ERASE TITLE and use the knob and softkeys to enter the serial numbers of the instrument and calibration kit, type of load and date. For example, INST=A12345/KIT=N67890/BROADBAND/DATE. Press DONE.
8. Press SCALE/REF REFERENCE POSITION [9] [x1] to position the display. Then press [SYSTEM] SERVICE MENU TESTS [3] [1] [x1] EXECUTE TEST [COPY] PLOT (or PRINT) to copy Cal Coef 1.
9. Repeat step 8, substituting the values of table 1 to plot cal coefficients 2 through 12.

Table 2–1. Suggested Scale and Repeatability Values for Cal Coef Plots

Cal Coef	Test	Scale (dB)	Repeatability
1 (E_{DF})	31	10	±5 dB
2 (E_{SF})	32	10	±2 dB
3 (E_{RF})	33	10	±1 dB
4 (E_{XF})	34	20	±5 dB
5 (E_{LF})	35	10	±2 dB
6 (E_{TF})	36	10	±0.5 dB
7 (E_{DR})	37	10	±5 dB
8 (E_{SR})	38	10	±2 dB
9 (E_{RR})	39	10	±1 dB
10 (E_{XR})	40	20	±5 dB
11 (E_{LR})	41	10	±2 dB
12 (E_{TR})	42	10	±0.5 dB

10. The plots generated should closely match previously generated plots. Variations due to connector repeatability factors are indicated in Table 2–1. Greater variations indicate a system degradation due to changes in the cal kit devices, the front panel test port connectors, or the network analyzer itself.

    To compare the plots to typical plots or to learn more about their significance, see the *Error Terms* or *Accessories* sections of this manual.

11. Store the plots for future reference and for use as troubleshooting tools.

CLEAN THE FAN FILTER

Clean the fan filter regularly. How regularly depends on the operating environment. It is a good idea to check it weekly and clean it as necessary. If the message, "CAUTION: Air Flow Restricted: Check Fan Filter" is displayed, immediately check for items (like a piece of paper) on the fan filter that may be impeding the air flow. If the fan filter is not blocked, clean it as follows:

1. Turn OFF the instrument and disconnect the HP–IB cables from the rear panel.
2. Remove the plastic fan filter retainer —use either a flat blade screwdriver or your fingers to pry it off; it should "pop" off easily.
3. Clean the foam fan filter with a vacuum cleaner or shake it out thoroughly to remove the dust and dirt. Clean fan filters are nearly translucent.
4. Replace the fan filter and snap on the fan filter retainer.

CLEAN THE GLASS FILTER (AND CRT AS REQUIRED)

1. A gasket between the CRT and glass filter limits air and dust infiltration between them. Thus cleaning the outer surface of the glass filter is usually sufficient. Use a soft cloth and, if necessary, a cleaning solution recommended for optical coated surfaces: HP part number 8500–2163 is one such solution.

   If, after cleaning the outer surface of the glass filter, the CRT appears dark or dirty or unfocused, continue with step 2 to clean the inner surface of the CRT.

2. Remove the softkeys cover (a plastic cover through which the front panel softkeys protrude): *carefully* insert a thin, flat screwdriver blade (or your fingernail) between the upper left corner of the softkeys cover and the glass filter (see Figure 2–1). Be extremely careful not to scratch or break the glass. Carefully pull the cover forward and off.

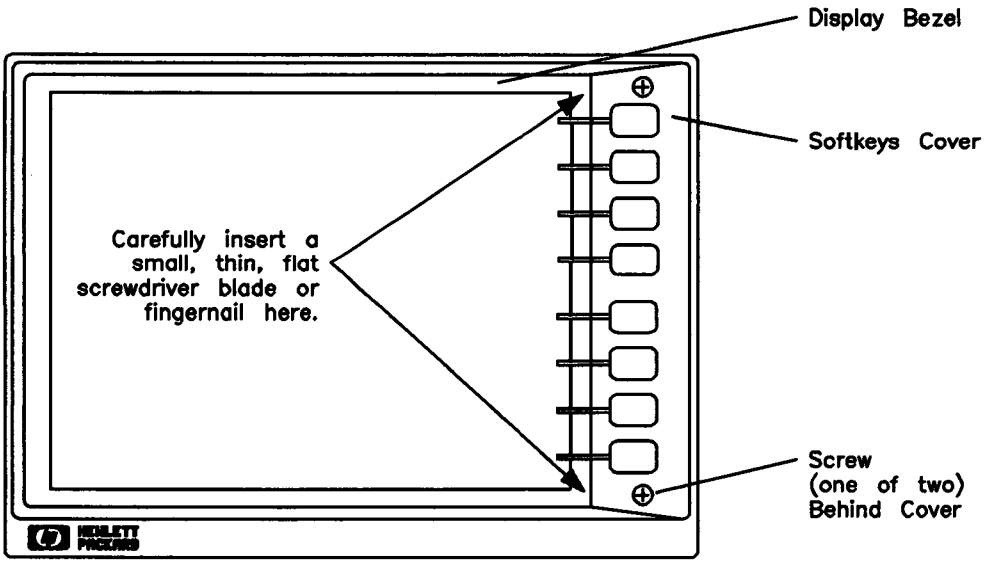

Display Bezel
Softkeys Cover
Carefully insert a small, thin, flat screwdriver blade or fingernail here.
Screw (one of two) Behind Cover

Figure 2–1. Removing the Glass Filter

3. Remove the two screws that are now uncovered.
4. Remove the display bezel assembly by pulling out the end that is now free and pivoting it around its left edge until it is released.
5. Clean the CRT surface and the inner glass filter surface gently, as in step 1.
6. Allow the surfaces to dry and then reassemble the instrument.

NOTE: Magnetic fields will cause distortion of the color display. Typical sources of magnetic fields are magnetized work benches, electric motors, power supplies, etc. Should you experience distortion, move the analyzer to a different location. If the problem does not go away, perform the display degaussing routine in chapter 5.

Chapter 3. Specifications

This section consists of two parts:

- System specifications
- General characteristics

Specifications

Specifications describe the instrument's warranted performance over the temperature range 0° to 55°C (except where noted).

Switch repeatability and overall measurement uncertainty are verified by executing the Total System Uncertainty test, which uses the standards comparison method.[1] Verification is viable for 2.4 mm, 3.5 mm, 7 mm and type−N connector types.

Source specifications can be verified after measurement calibration by executing the Performance Tests.[1]

Measurement port specifications are factory−tested only. They are not field verifiable, and are dependent upon the calibration kit in use meeting its specifications..

1. Refer to Chapter 4, *System Performance and Verification.*

UNCORRECTED PERFORMANCE

The following table shows typical performance without accuracy enhancement.

Table 3–1. Typical Performance without Accuracy Enhancement

	Frequency Range			
	.050 to 2 GHz	**2 to 8 GHz**	**8 to 20 GHz**	**20 to 40 GHz**
Directivity	20 dB	18 dB	18 dB	16 dB
Source Match (Standard)	20 dB[1]	15 dB	12 dB	8 dB
Source Match (Opt. 006)	17 dB[2]	12 dB	9 dB	5 dB
Load Match[3] (Standard)	23 dB	18 dB	14 dB	12 dB
Load Match (Opt. 006)	18 dB	15 dB	11 dB	9 dB
Reflection Tracking[4]	±1.5 dB	±2 dB	±2.5 dB	±3 dB
Transmission Tracking (Standard)[3,4,5]	±1.5 dB	±2 dB	±2 dB	±2.5 dB
Transmission Tracking (Opt. 006)	±1.5 dB	±2 dB	±2.8 dB	±2.8 dB
Crosstalk	85 dB	85 dB	85 dB	70 dB

1. 18 dB, 0.05 to 0.65 GHz.
2. 17 dB, 0.05 to 0.65 GHz.
3. Measured with RF cables.
4. Excludes +0/−5 dB slope, typical, in magnitude response from 0.84 to 40 GHz and rolloff below 0.84 GHz, which is typically −3 dB at 500MHz, −15 dB at 100 MHz, and − 20 dB at 50 MHz.
5. ±3 dB for Opt. 003.

SOURCE SPECIFICATIONS

SOURCE FREQUENCY SPECIFICATIONS

Frequency Range:	50 MHz to 40 GHz
Frequency resolution:	100 kHz (standard); 1 Hz with Option 001; Accuracy and stability not affected by Option 001.
Frequency accuracy:	10 ppm at 23°±3°C (can be locked to external frequency reference)
Frequency stability (typical):	±7.5 ppm over 0° to 55°C (temperature) ±3 ppm per year (aging)
Spectral purity (typical):	
Harmonics:	<−15 dBc at +10 dBm
Phase noise:	<−35 dBc to 60 kHz from carrier
Spurs:	<−40 dBc at 100 kHz <−50 dBc at 200 kHz <−65 dBc at >200 kHz

SOURCE POWER SPECIFICATIONS (23° ± 3°C)

Table 3–2. Power Range and Power Sweep

POWER RANGE	
Power Range HP 8722A	−65 to −15 dBm ±3.5 dB flatness
HP 8722C (Standard)	−65 to 0 dBm ±3.5 dB flatness (50 MHz to 26.5 GHz) −65 to −5 dBm ± 3.5 dB flatness (26.5 GHz to 40 GHz)
HP 8722C (Option 006)	−65 to −5 dBm ±2.0 dB flatness (50 MHz to 26.5 GHz) −65 to -10 dBm ±4.0 dB flatness (26.5 GHz to 40 GHz)
Resolution	0.05 dB
POWER SWEEP	
Range	10 dB
Linearity	±0.5 dB
Linearity (<5 dB sweep)	±0.2 dB

Power accuracy: ±0.5 dB at 2 GHz maximum power.

GENERAL CHARACTERISTICS

MEASUREMENT THROUGHPUT SUMMARY

The following table shows typical measurement times for the analyzer. This information is based on 50 MHz to 40 GHz sweep with 3 kHz IF bandwidth, including system retrace time and all source band changes; 2–port times based on chop mode.

Table 3–3. Typical time for completion (msec) (1 of 2)

MEASUREMENT TIME (ms) VERSUS NUMBER OF POINTS (typical)					
Measurement	**3**	**51**	**101**	**201**	**1601**
1–port (3 term) #	410	515	525	550*	1320
Full 2–port	800	1040	1140	1355	4870
Fast 2–port	410	530	600	745	3100
Time domain conversion	15	180	300	540	2840
HP–IB data transfer					
1: Binary	10	28	40	62	450
2: 32–bit	12	48	80	160	1180
3: 64 bit	15	65	120	235	1790
4: ASCII	40	480	940	1860	14700
5: 32–bit PC	12	48	86	165	1260
* Reference used for following comparisons.					

MEASUREMENT TIME VERSUS SWEEP MODE (typical)	
Sweep Mode	**Time (ms)**
Linear	550
Log	1270
List	1270
CW Time	170
Power	890

MEASUREMENT TIME VERSUS FREQUENCY SPAN (typical)	
Frequency Range	**Time (ms)**
0.05 to 20 GHz	**530**
5 to 15 GHz	280
8 to 12 GHz	275
9 to 11 GHz	245

Table 3–3. Typical time for completion (msec) (2 of 2)

MEASUREMENT TIME VERSUS IF BANDWIDTH (typical)	
IF bandwidth	**Time (ms)**
3000	**530**
1000	660
300	1100
100	2400
30	7500
10	2200
# Measurements with no error correction, response, or response/isolation cals are similar.	

REAR PANEL CONNECTORS

BIAS CONNECT: DC bias input to internal tees, one for each port; internally fused to 500 mA maximum; 40 Vdc maximum

EXT REF IN: external frequency reference input, to which network analyzer locks its internal timebase; external reference must have following characteristics:

Frequency: 1 MHz ± 20 Hz
2 MHz ± 40 Hz
5 MHz ± 100 Hz
10 MHz ± 200 Hz
Level: −10 to +20 dBm
Impedance: 50 ohms

EXT TRIGGER: external trigger input, activated on negative TTL transition (+5 to 0V); internal 10 k−ohm pull−up resistor allows use of contact closure to ground; input can trigger these functions:

Sweep: begins entire sweep when armed
Point: acquires single data point of multi−point sweep

EXT AM: external AM input; 0 to +10 V into 100 k ohm; approximately −2 dB/volt sensitivity; 1 kHz maximum

AUX INPUT: auxiliary voltage input; −10 to +10 V; can be measured with "analog bus" and displayed as voltage on vertical axis in real format

IO INTERCONNECT (DB−25):
pin 17: limit test output; LS TTL, +5V=pass, 0V=fail
pin 14: +22 Vdc power supply output
pin 8: transfer switch output; LS TTL, +5 V=forward, 0V= reverse

EXT MON (RED/GREEN/BLUE): video outputs to drive external monitors with the following characteristics:

Format: RGB (red green/blue) with sync on green
Impedance: 75 ohms
Horizontal scan rate: 25.5 kHz
Refresh rate: 60 Hz
Level: 1 Vp−p

Compatible monitors:
HP 35731A/B monochrome monitor
HP 35741A/B color monitor
Most other analog multi–sync monitors

EFFECT OF FREQUENCY RESOLUTION

The following table shows the differences in operation between the standard analyzer (100 kHz frequency resolution) and the option 001 (1 Hz frequency resolution) analyzer.

Table 3–4

	Standard	Option 001
Source Control		
Start/Stop/Center CW	100 kHz	1 Hz
Min. span @ 101 points [1]	10 MHz	100 Hz
Min. span @ 201 points	20 MHz	200 Hz
Time domain:		
Max. time domain range [2]	10 µs	1s
Group delay:		
Max. group delay range	5 µs	500 ms
Minimum aperture	100 kHz	1 Hz

1. Minimum span = (number of data points – 1) (frequency resolution)
2. Using time domain bandpass mode.

Supplemental Characteristics

Supplemental characteristics are intended to provide information useful in applying the instrument, by giving typical but non–warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

Table 3–5. Dynamic Range Specification (for transmission measurements)[1]

8722A Dynamic Range	Frequency Range			
	0.05 to 2 GHz	2 to 8 GHz	8 to 20 GHz	20 to 40 GHz
Standard	80 dB[2]	78 dB	76 dB	71 dB
Opt. 003 (forward)	95 dB	93 dB	90 dB	76 dB
Opt. 003 (reverse)	70 dB[3]	68 dB	68 dB	59 dB
8722C				
Standard[4]	98 dB[5]	98 dB	93 dB[6]	87 dB
Opt. 003 (forward)	107 dB	107 dB	102 dB[6]	96 dB
Opt. 003 (reverse)	82 dB[7]	82 dB	80 dB[6]	79 dB
Opt. 006	93 dB	93 dB	88 dB	82 dB

1. Limited by maximum output power and system low level noise peaks. Specified for an IF bandwidth of 10 Hz, using a full 2–port calibration (including an isolation calibration performed with an averaging factor of 16).
2. Rolls off below 840 MHz to 61 dB at 50 MHz.
3. Rolls off below 840 MHz to 25 dB at 50 MHz.
4. With HP 85133E flexible cable on test port.
5. Rolls off below 840 mHz to 76 dB at 50 MHz.
6. Valid to 26.5 GHz.
7. Rolls off below 840 MHz to 40 dB at 50 MHz

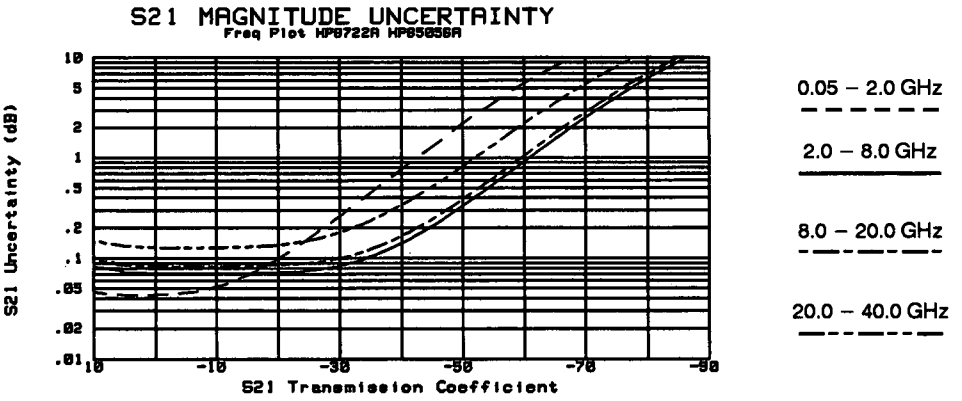
2.4 MM SYSTEM SPECIFICATIONS

DEVICES WITH 2.4 MM CONNECTORS

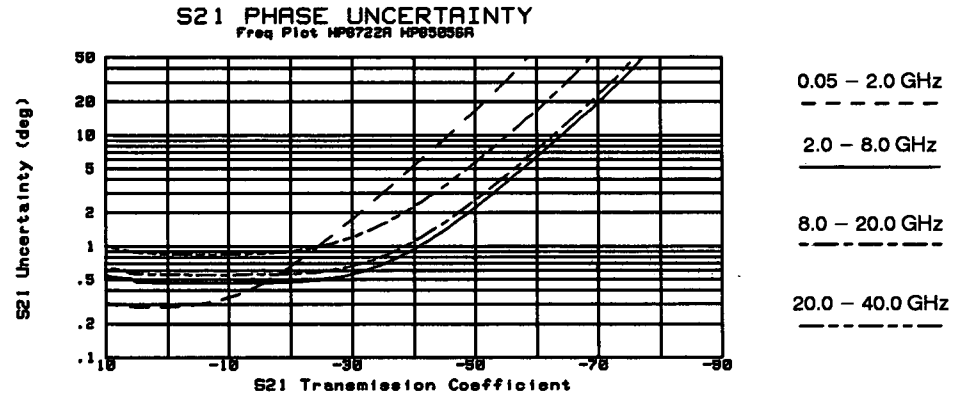
Measurement Uncertainty: HP 85056A Calibration Kit

The following graphs show total worst case uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85056A 2.4 mm calibration kit, HP 85133D cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 2.4 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85057B verification kit.

Transmission Measurements[2] HP 8722A



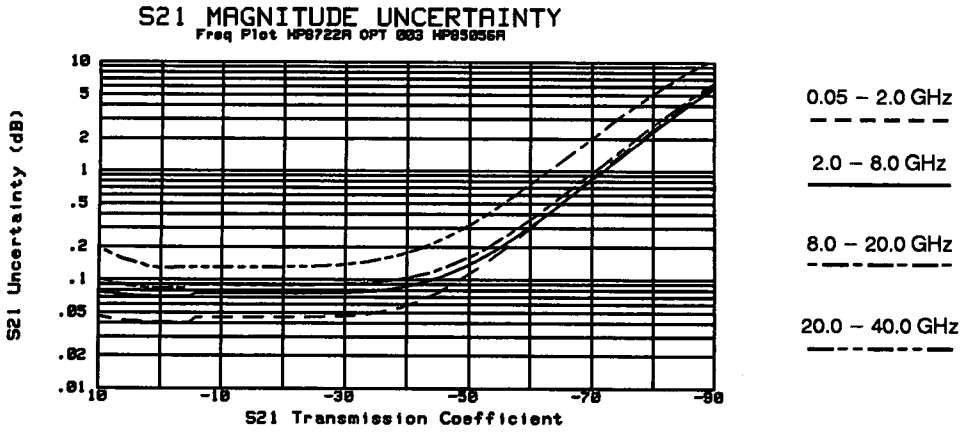
Magnitude



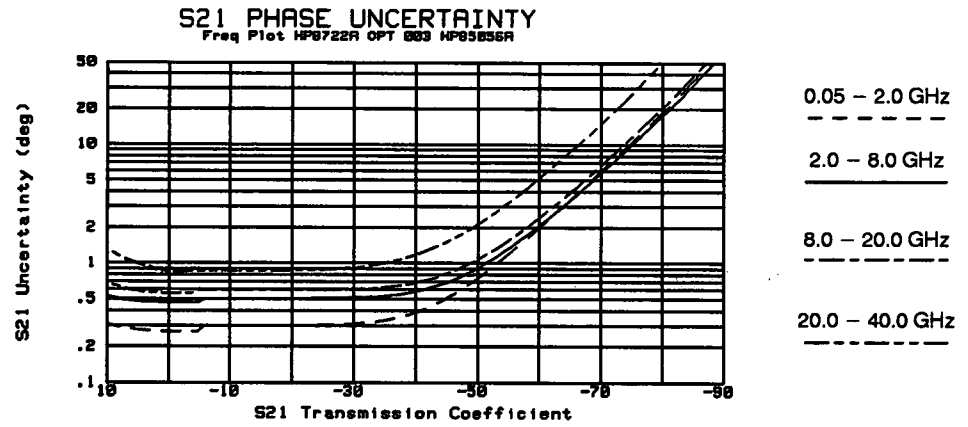
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

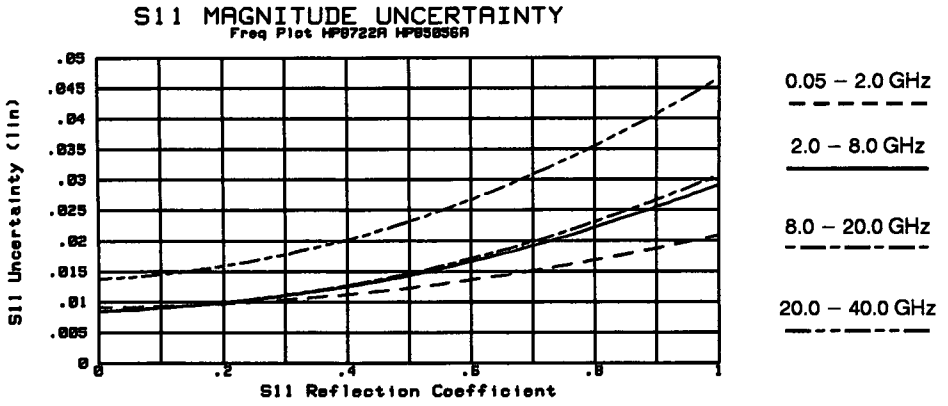


Magnitude

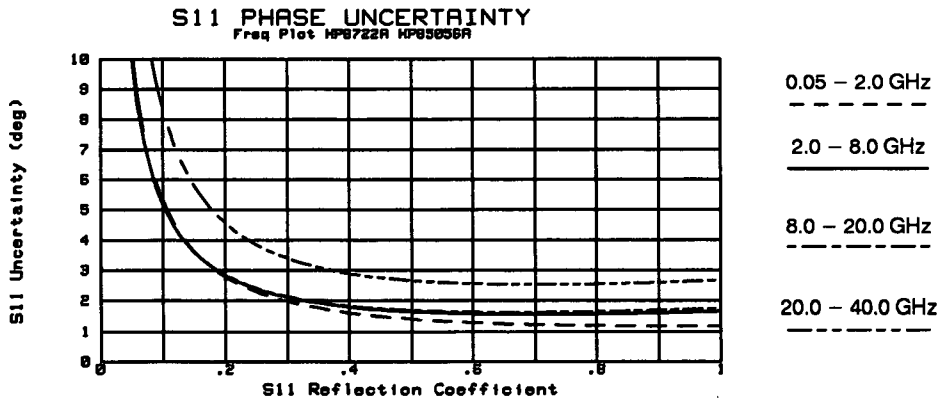


Phase

\Reflection Measurements[1] HP 8722A



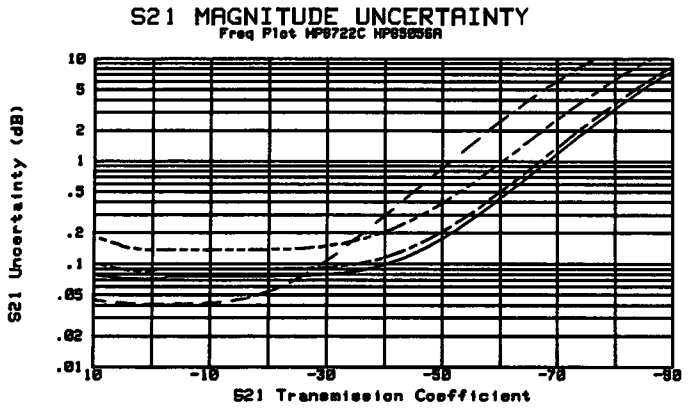
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C



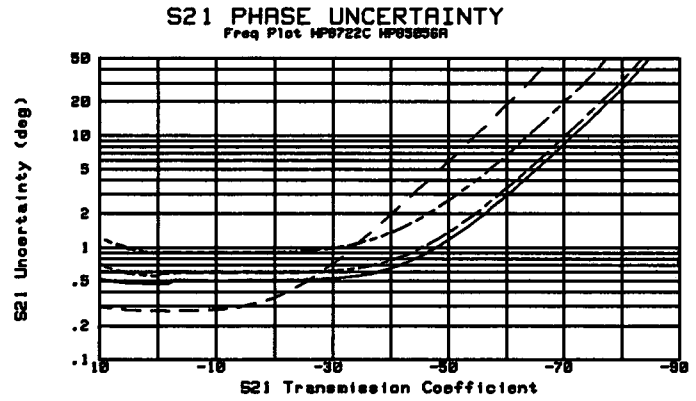
0.05 – 2.0 GHz

2.0 – 8.0 GHz

8.0 – 20.0 GHz

20.0 – 40.0 GHz

Magnitude



0.05 – 2.0 GHz

2.0 – 8.0 GHz

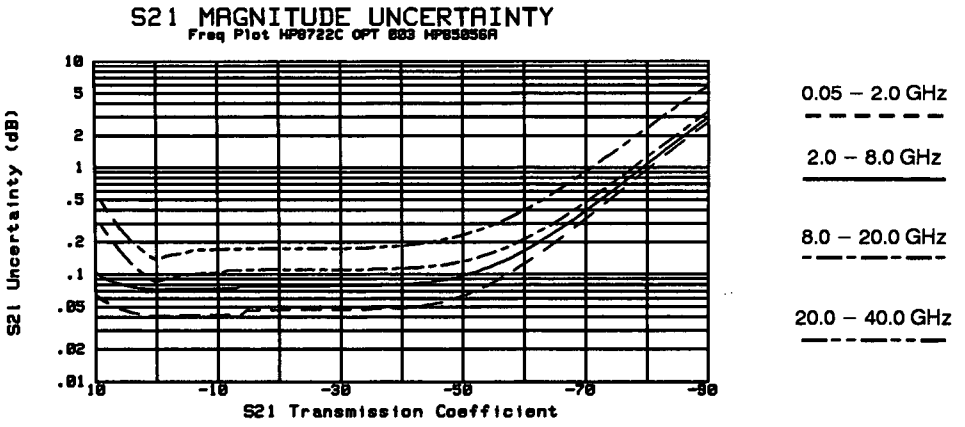
8.0 – 20.0 GHz

20.0 – 40.0 GHz

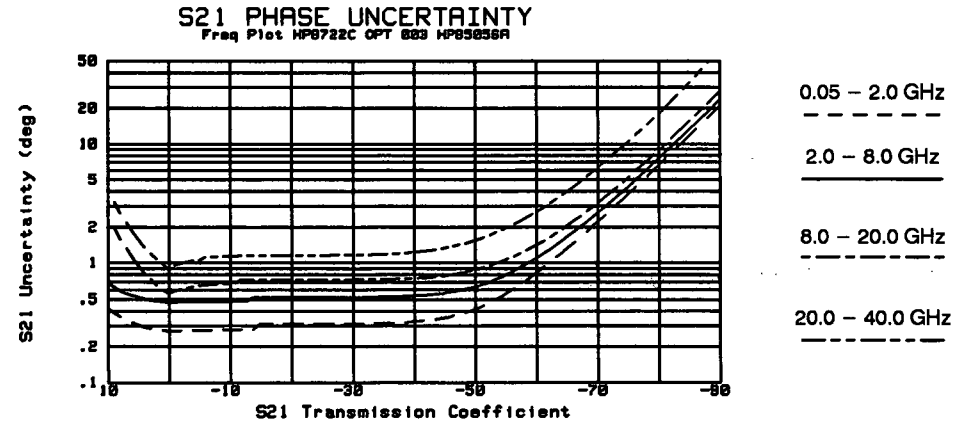
Phase

1. The graphs for transmission measurements assume a well-matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

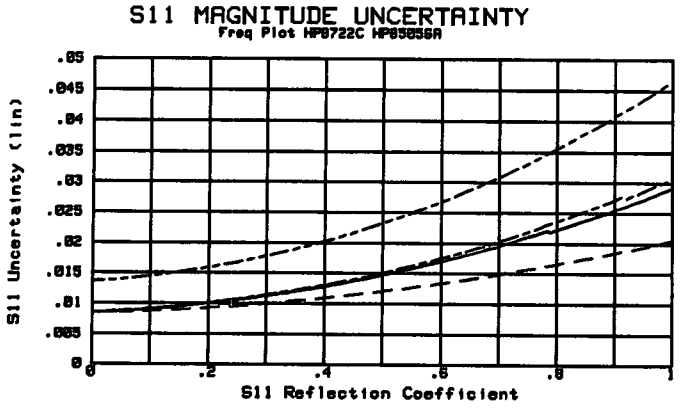


Magnitude



Phase

Reflection Measurements[1] HP 8722C



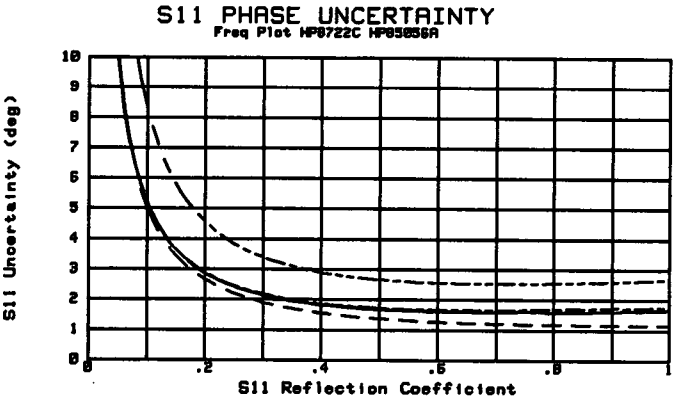
0.05 – 2.0 GHz

2.0 – 8.0 GHz

8.0 – 20.0 GHz

20.0 – 40.0 GHz

Magnitude



0.05 – 2.0 GHz

2.0 – 8.0 GHz

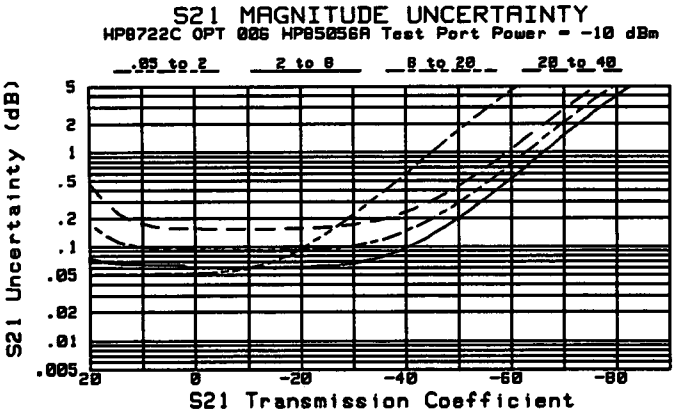
8.0 – 20.0 GHz

20.0 – 40.0 GHz

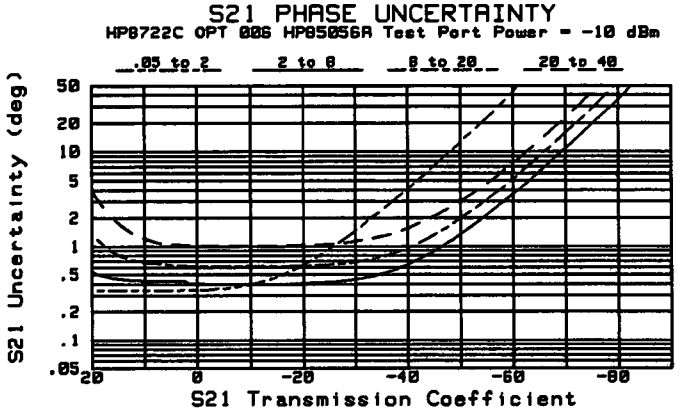
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements (Option 006 only) HP 8722C

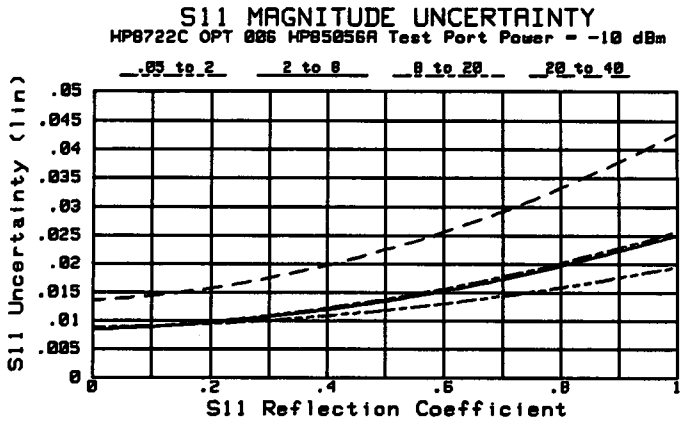


Magnitude

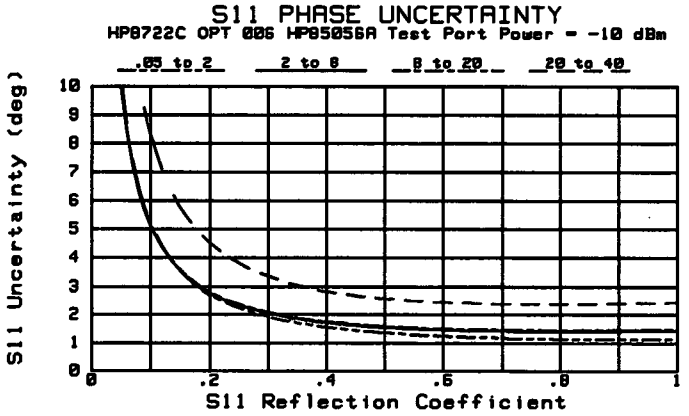


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2-port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

Calibration Kit: HP 85056A (male and female lowband and sliding loads)

Table 3-6. HP 85056A

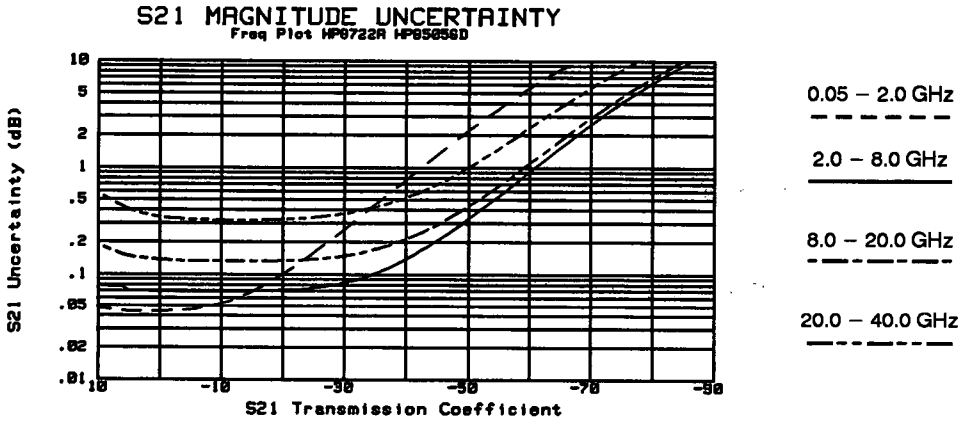
	Frequency Range			
	.050 to 2 GHz	2 to 8 GHz	8 to 20 GHz	20 to 40 GHz
Directivity	42 dB	42 dB	42 dB	38 dB
Source Match	40 dB	35 dB	34 dB	31 dB
Load Match	41 dB	38 dB	37 dB	35 dB
Reflection Tracking	.011 dB	.037 dB	.039 dB	.045 dB
Transmission Tracking	.017 dB	.051 dB	.075 dB	.118 dB

1. Crosstalk, after an isolation calibration, is no higher than the system noise floor and can be ignored.

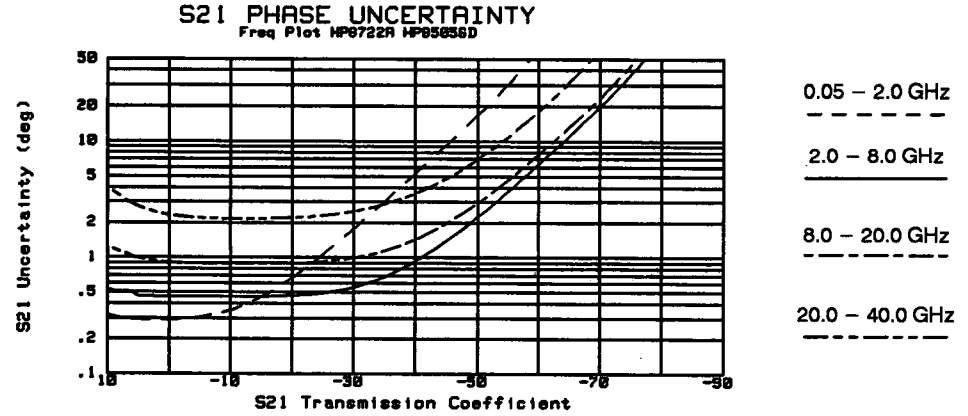
Measurement Uncertainty: HP 85056D Calibration Kit

The following graphs show total worst case uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85056D 2.4 mm calibration kit, HP 85133D cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 2.4 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85057B verification kit.

Transmission Measurements[2] HP 8722A



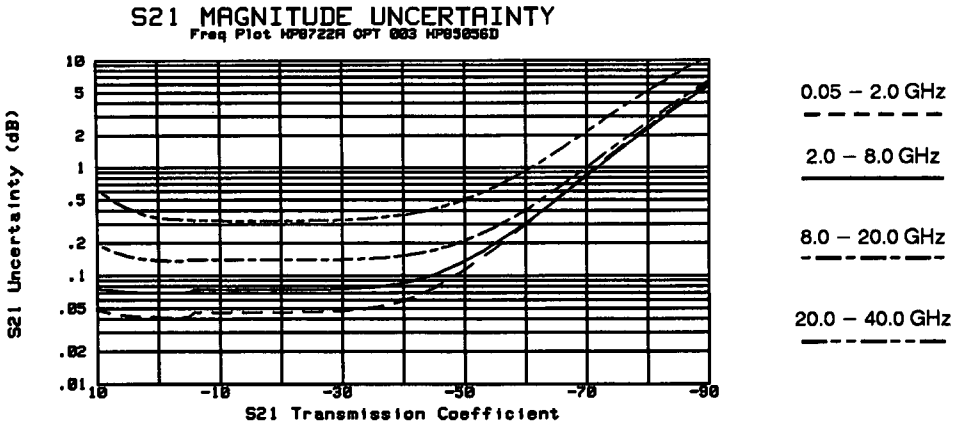
Magnitude



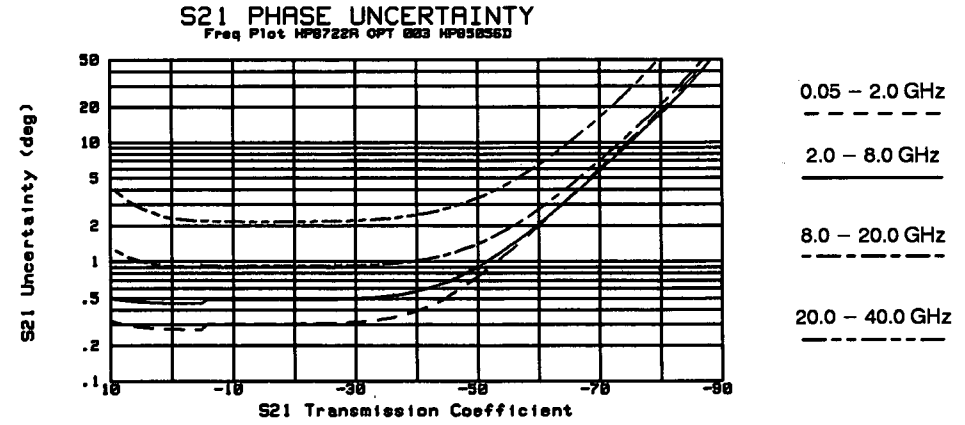
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

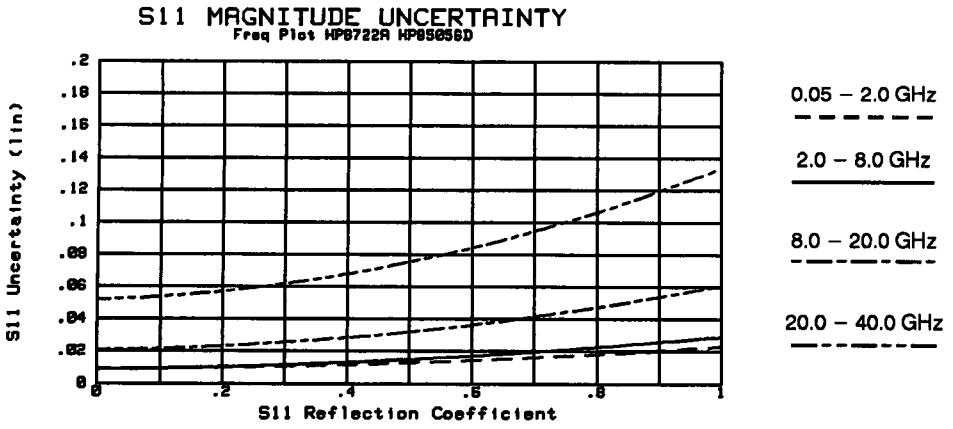


Magnitude

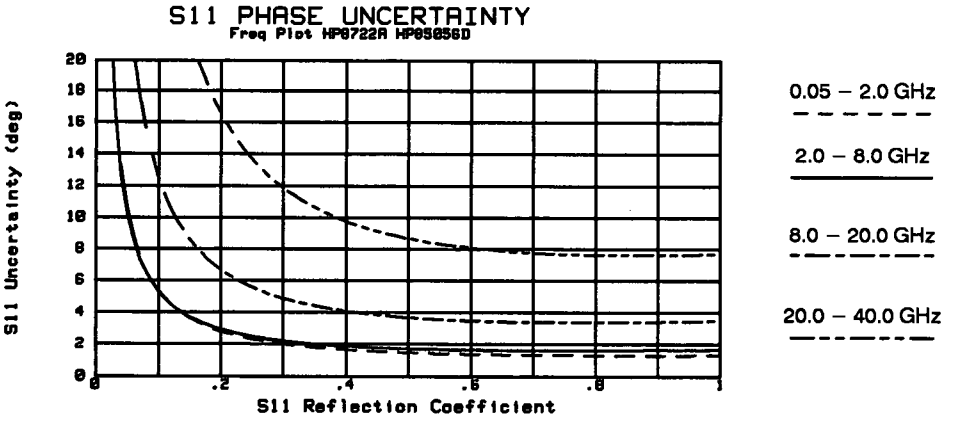


Phase

Reflection Measurements[1] HP 8722A



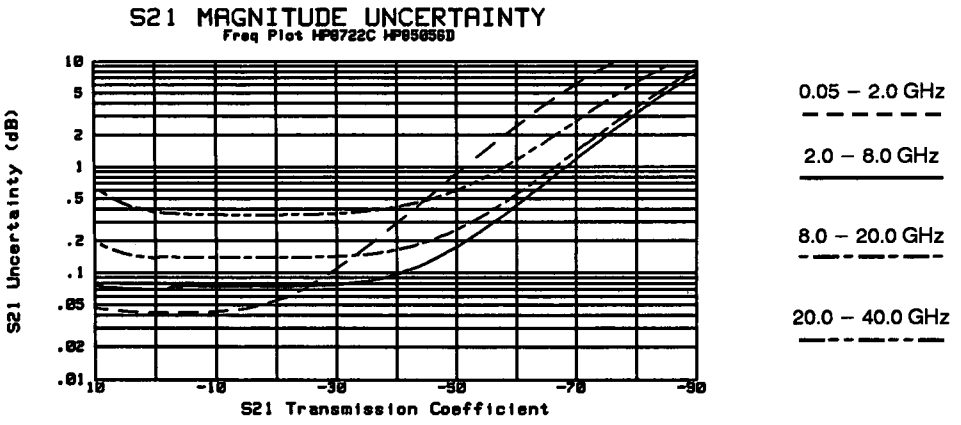
Magnitude



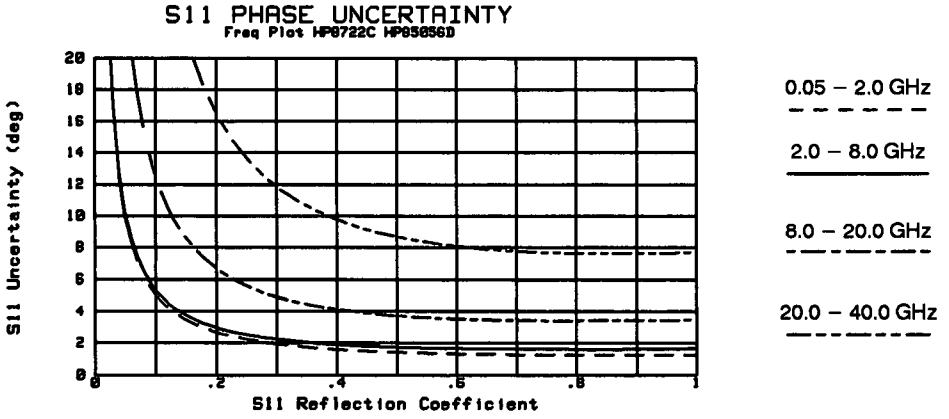
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C



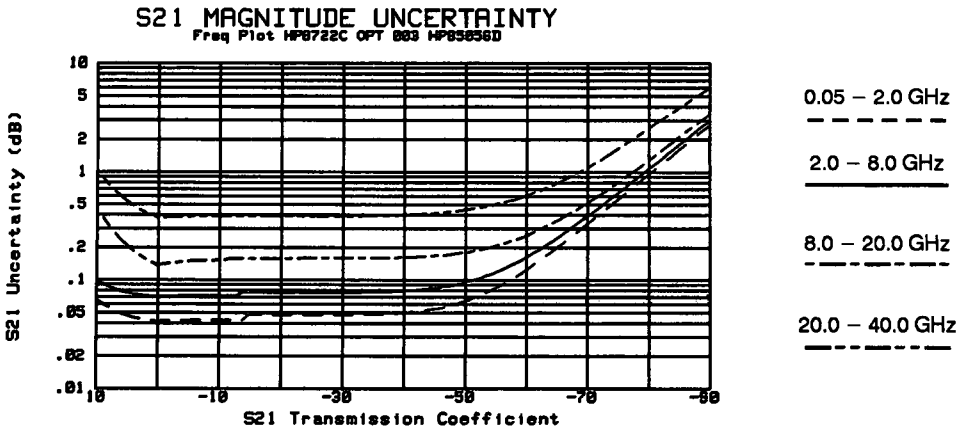
Magnitude



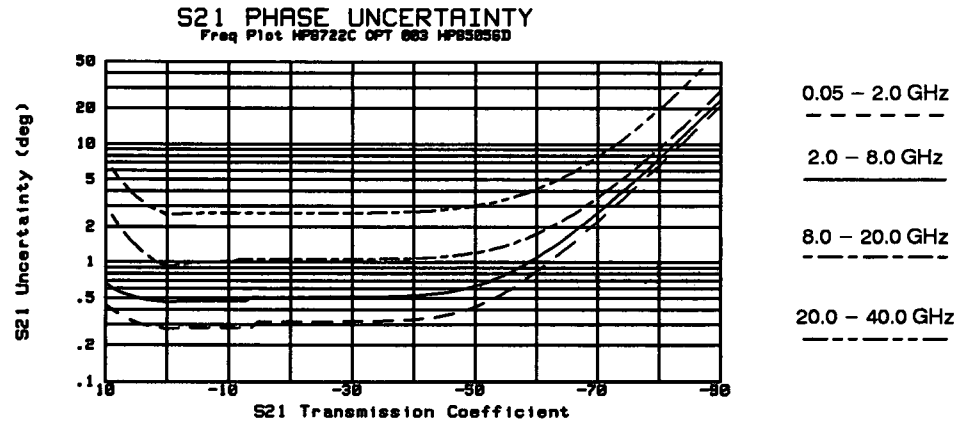
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

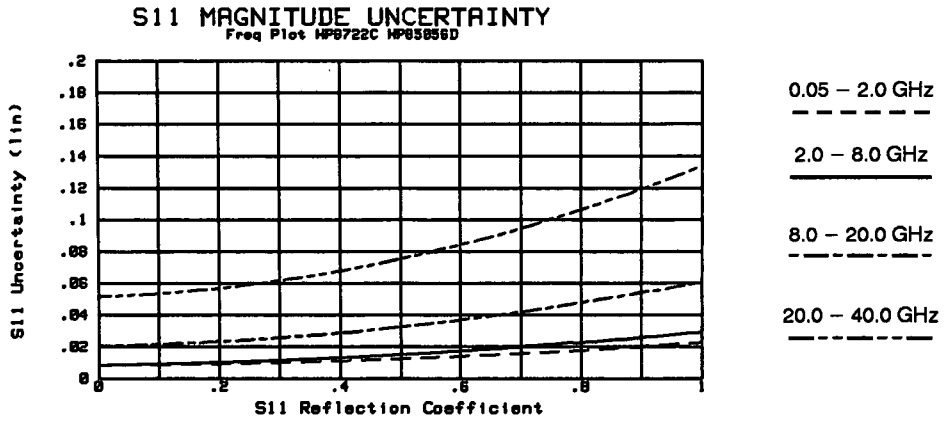


Magnitude

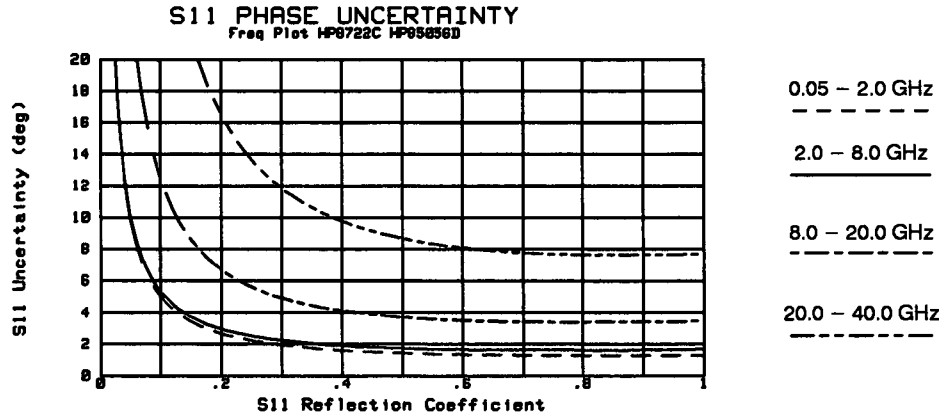


Phase

Reflection Measurements[1] HP 8722C



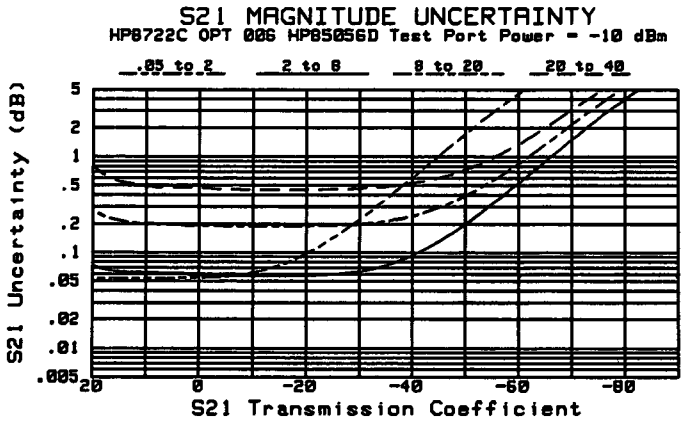
Magnitude



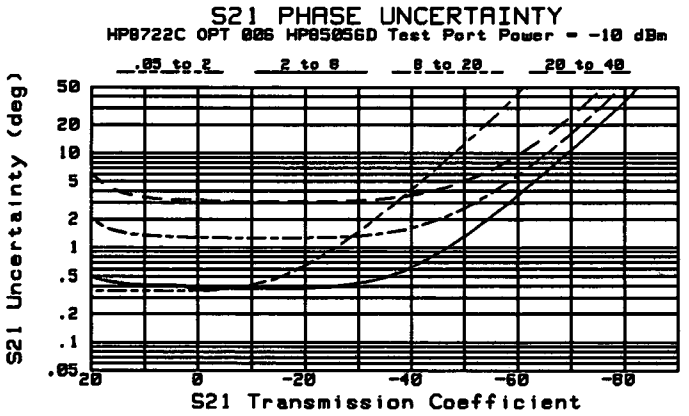
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one-port device.

Transmission Measurements (Option 006 only) HP 8722C

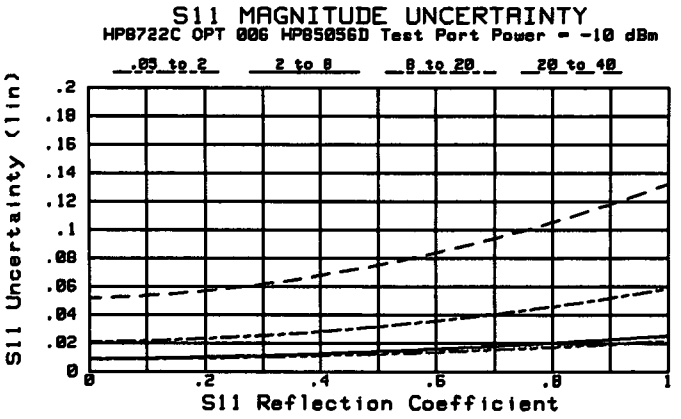


Magnitude

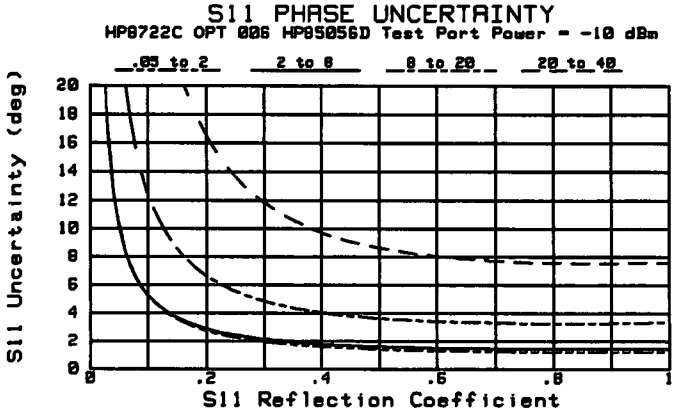


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2-port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23°±3°C.

Calibration Kit: HP 85056D (male and female lowband and sliding loads)

Table 3-7. HP 85056D

	Frequency Range			
	.050 to 2 GHz	2 to 8 GHz	8 to 20 GHz	20 to 40 GHz
Directivity	41.9 dB	41.9 dB	33.9 dB	25.9 dB
Source Match	38.87 dB	35.72 dB	29.19 dB	23.20 dB
Load Match	41.28 dB	38.42 dB	32.73 dB	25.64 dB
Reflection Tracking	.018 dB	.050 dB	.12 dB	.328 dB
Transmission Tracking	.017 dB	.051 dB	.075 dB	.118 dB

1. Crosstalk, after an isolation calibration, is no higher than the system noise floor and can be ignored.

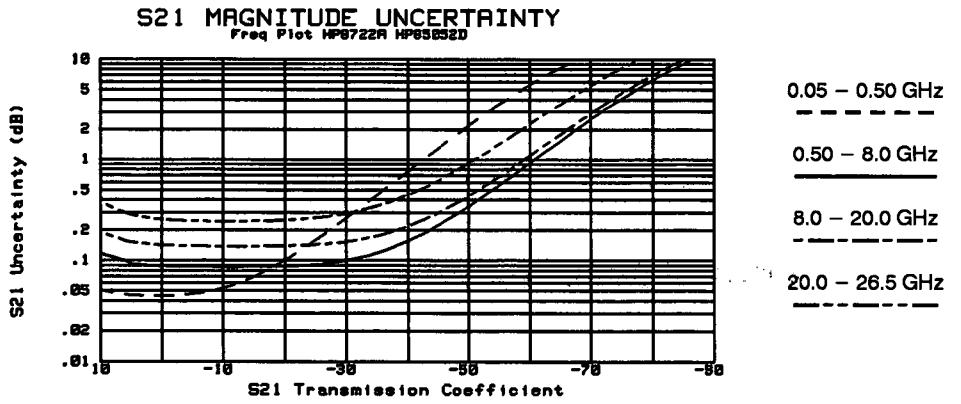
3.5 MM SYSTEM SPECIFICATIONS

DEVICES WITH 3.5 MM CONNECTORS

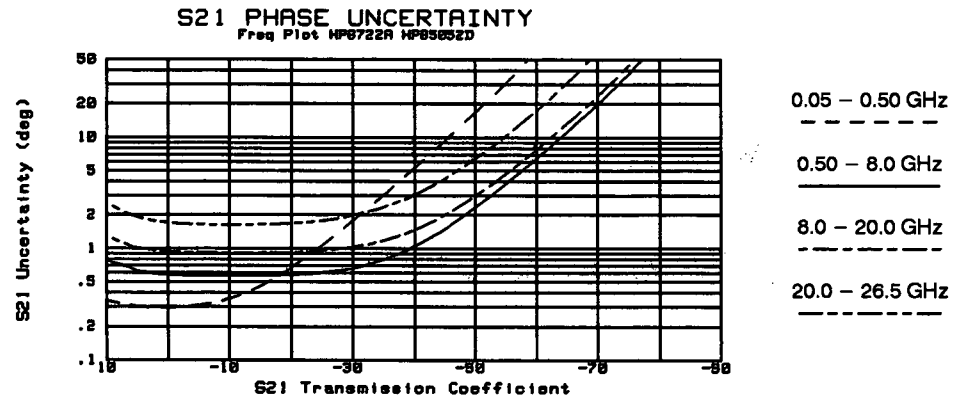
Measurement Uncertainty: HP 85052D Calibration Kit

The following graphs show total worst case uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85052D 3.5 mm calibration kit, HP 85134D 3.5 mm cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 3.5 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85053B verification kit, up to 20 GHz.

Transmission Measurements[2] HP 8722A



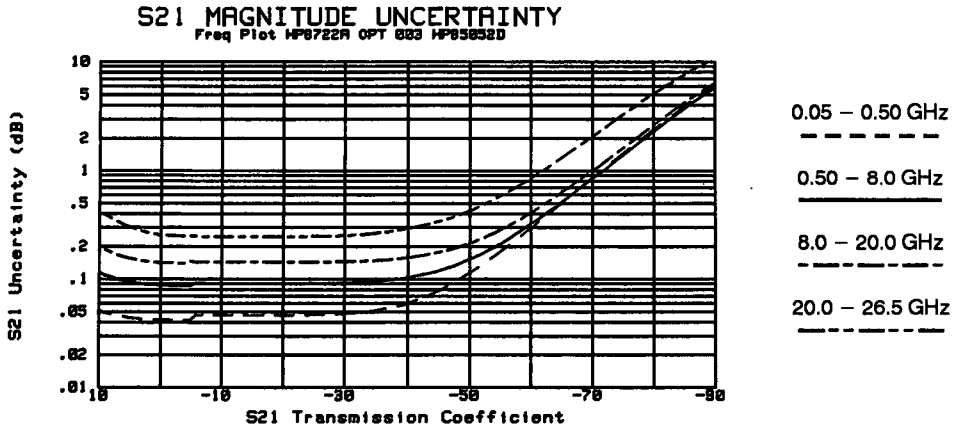
Magnitude



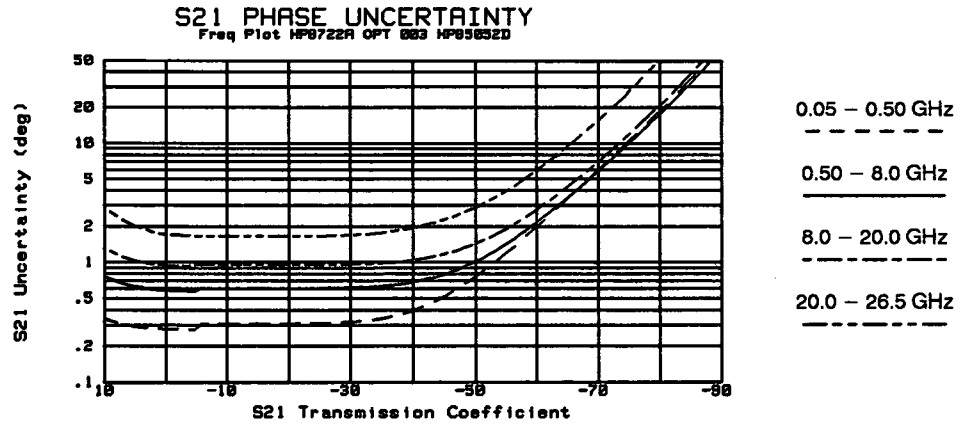
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

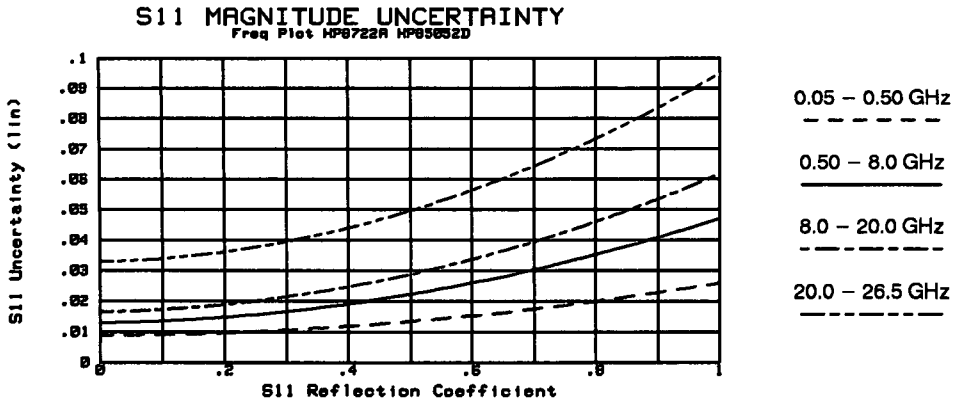


Magnitude

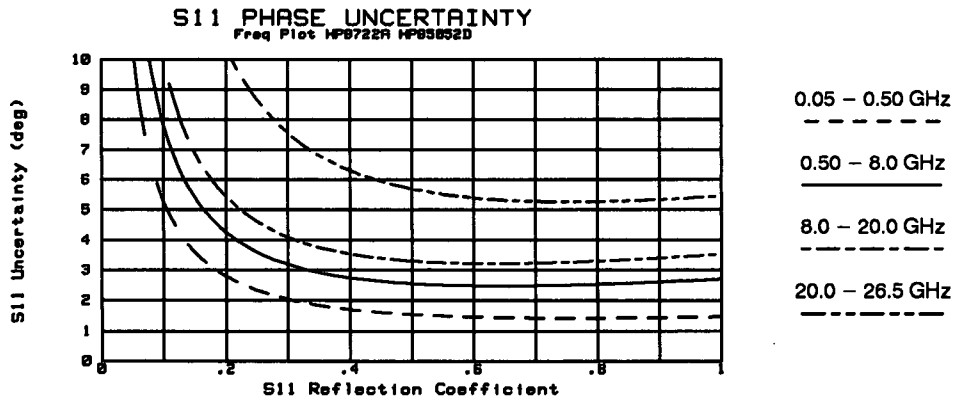


Phase

Reflection Measurements[1] HP 8722A



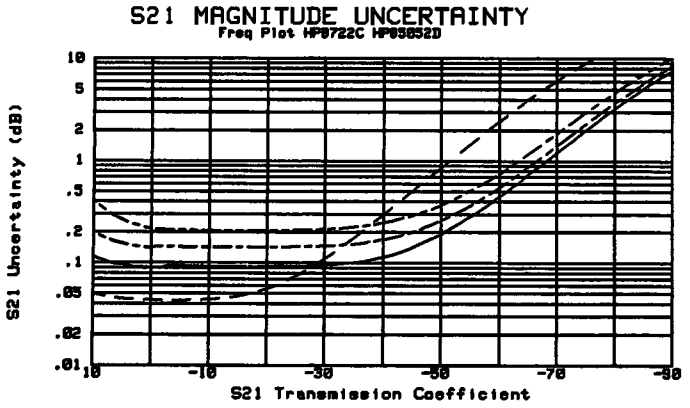
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C



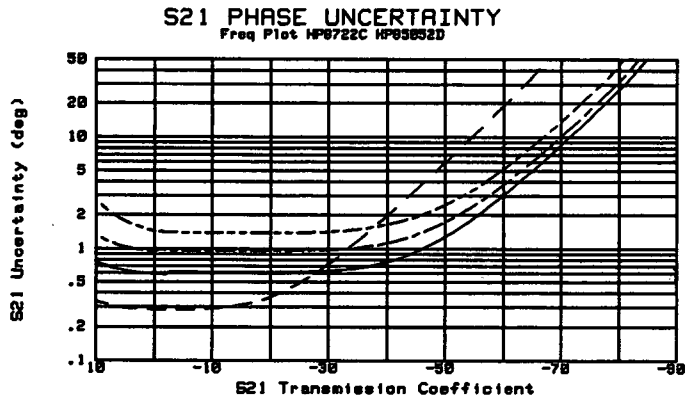
0.05 – 0.50 GHz

0.50 – 8.0 GHz

8.0 – 20.0 GHz

20.0 – 26.5 GHz

Magnitude



0.05 – 0.50 GHz

0.50 – 8.0 GHz

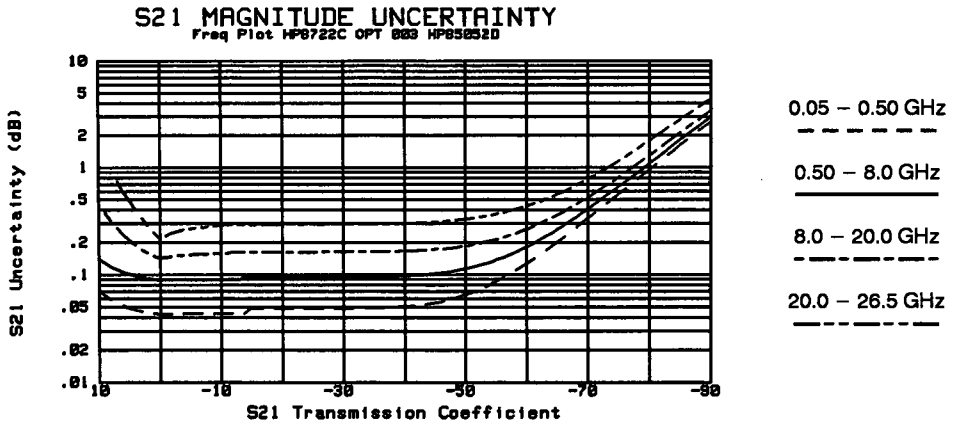
8.0 – 20.0 GHz

20.0 – 26.5 GHz

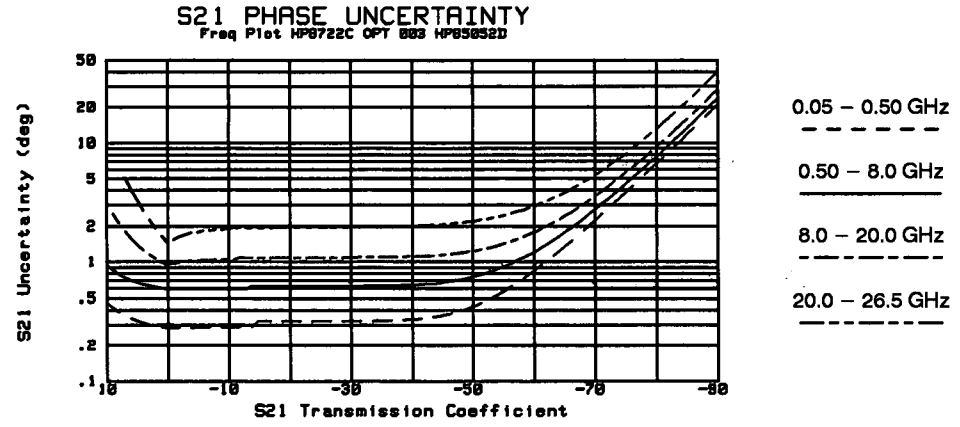
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

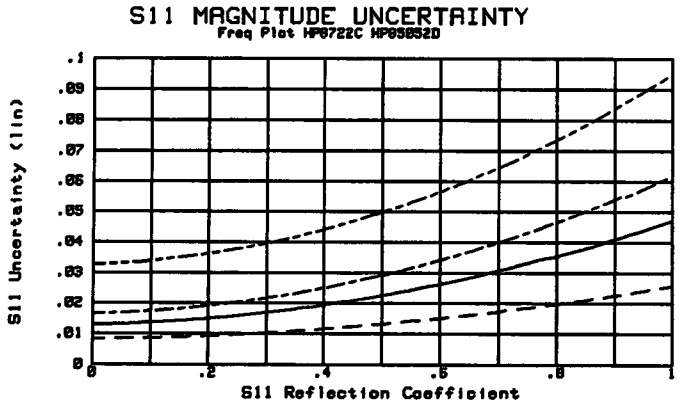


Magnitude



Phase

Reflection Measurements[1] HP 8722C



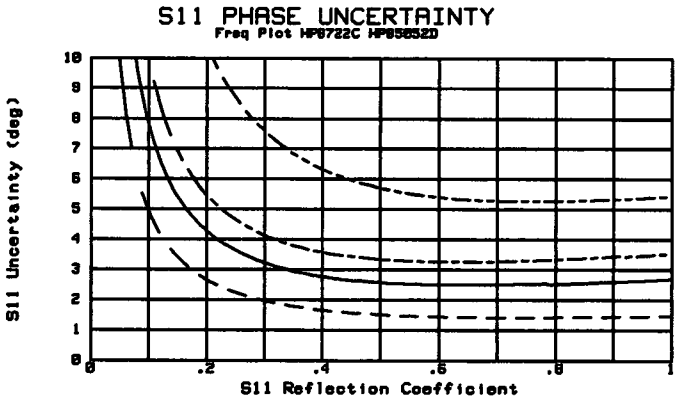
0.05 – 0.50 GHz

0.50 – 8.0 GHz

8.0 – 20.0 GHz

20.0 – 26.5 GHz

Magnitude



0.05 – 0.50 GHz

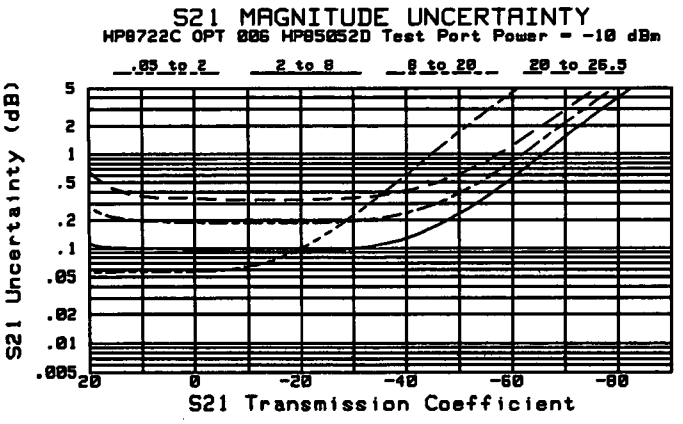
0.50 – 8.0 GHz

8.0 – 20.0 GHz

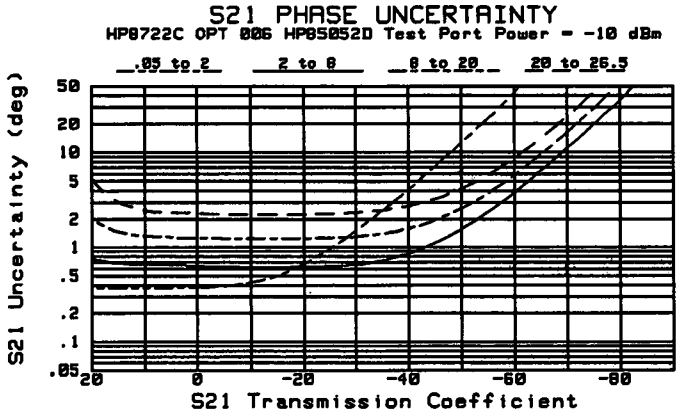
20.0 – 26.5 GHz

Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

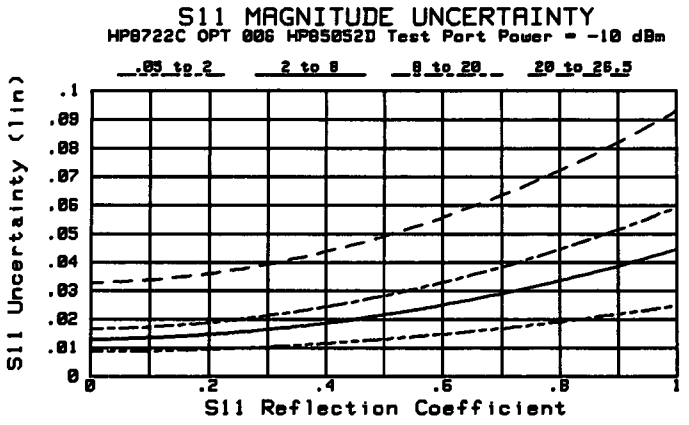


Magnitude

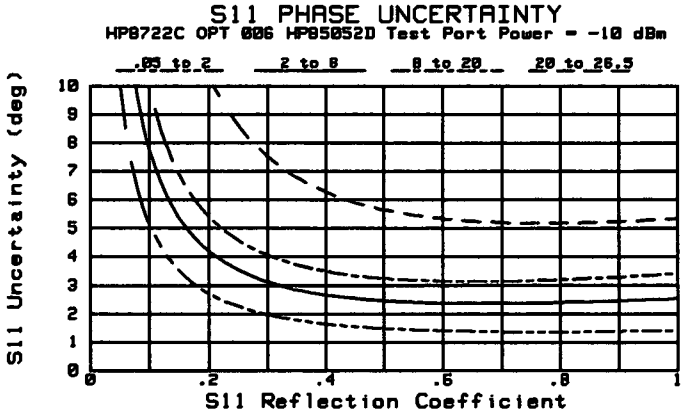


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2–port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

Calibration Kit: HP 85052D (male and female broadband precision fixed loads)

Table 3–8. HP 85052D

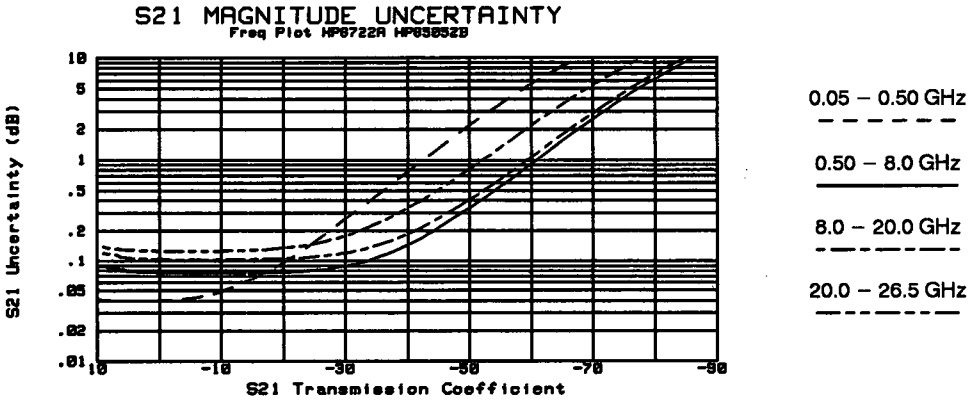
	Frequency Range			
	.05 to .50 GHz	**.50 – 8 GHz**	**8 to 20 GHz**	**20 to 26.5 GHz**
Directivity	42 dB	38 dB	36 dB	30 dB
Source Match	37 dB	30 dB	28 dB	25 dB
Load Match	41 dB	36 dB	34 dB	29 dB
Reflection Tracking	.011 dB	.036 dB	.039 dB	.040 dB
Transmission Tracking	.019 dB	.066 dB	.119 dB	.238 dB

1. Crosstalk, after an isolation calibration, is no higher than the system noise floor and can be ignored.

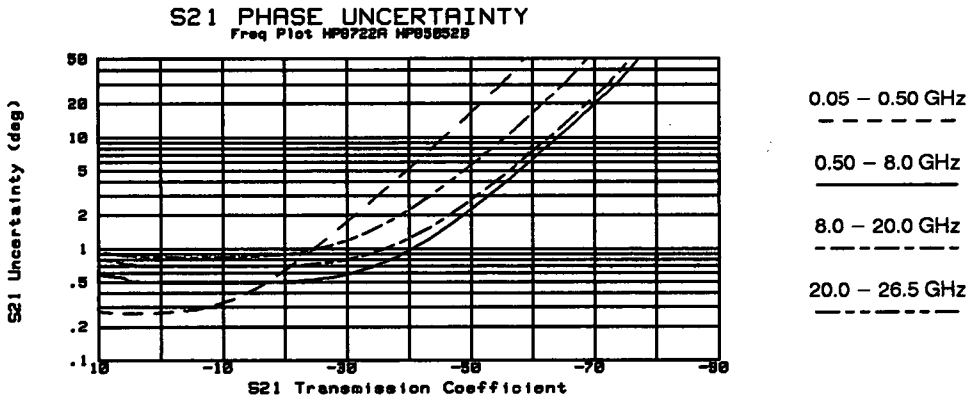
Measurement Uncertainty: HP 85052B Calibration Kit

The following graphs show total worst case uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85052B 3.5 mm calibration kit, HP 85134D 3.5 mm cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 3.5 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85053B verification kit, up to 20 GHz.

Transmission Measurements[2] HP 8722A



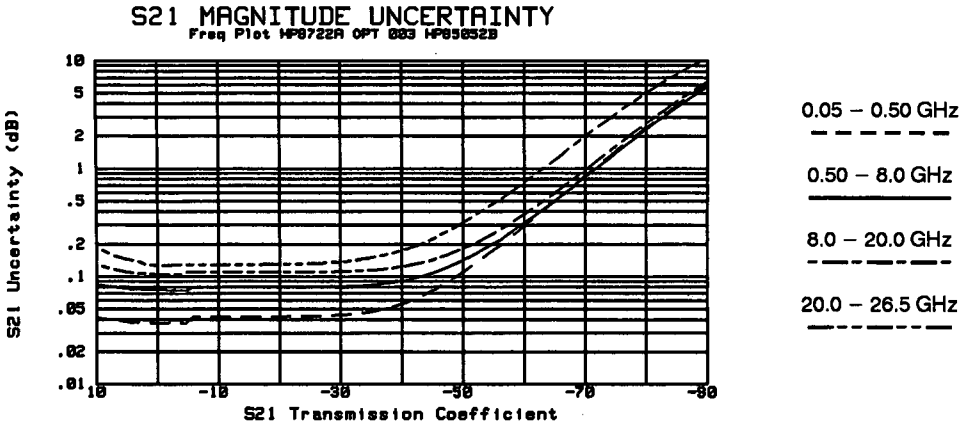
Magnitude



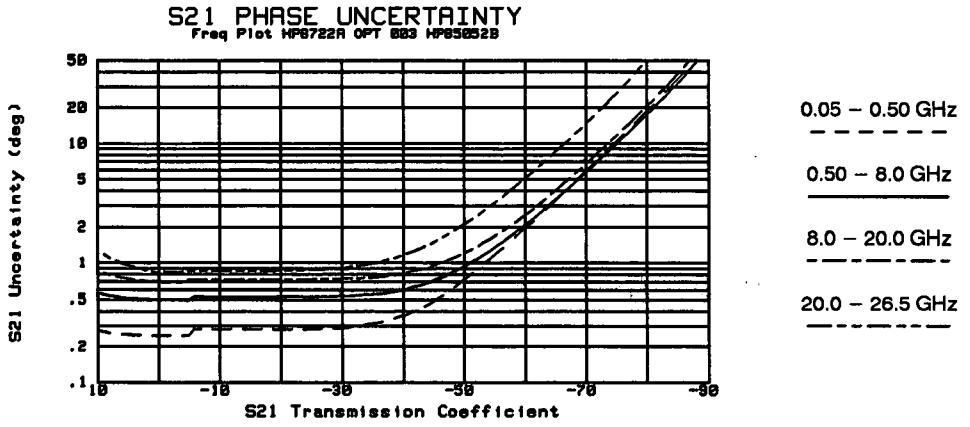
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

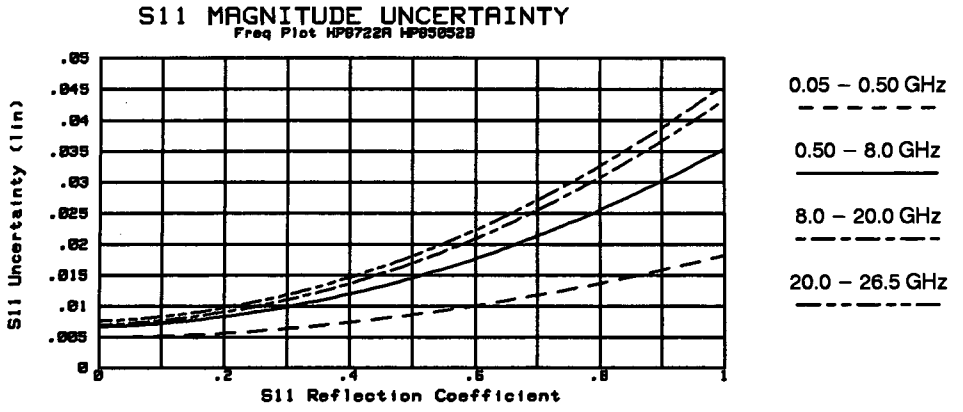


Magnitude

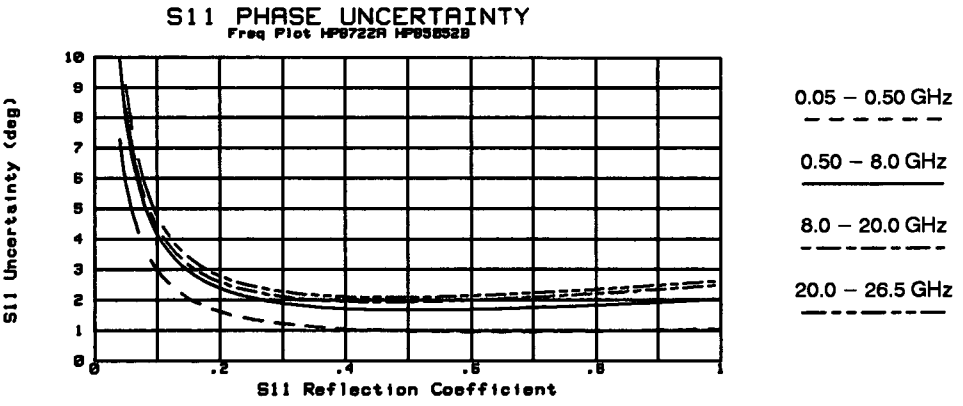


Phase

Reflection Measurements[1] HP 8722A



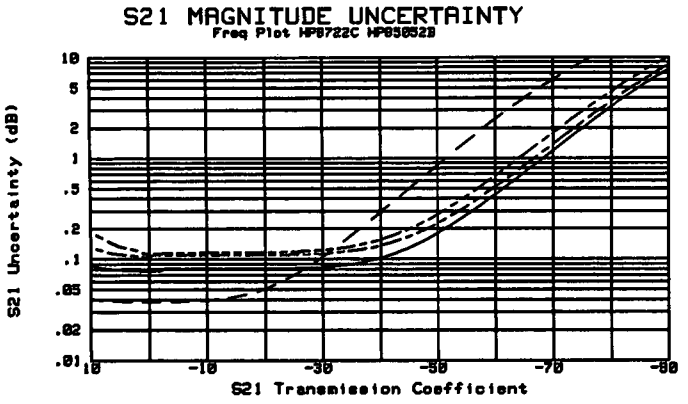
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C



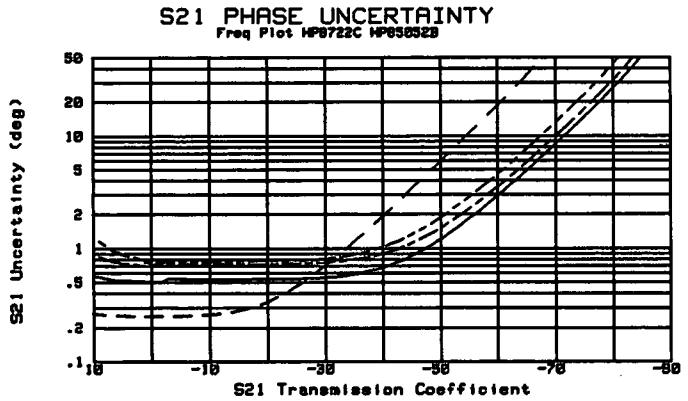
0.05 – 0.50 GHz

0.50 – 8.0 GHz

8.0 – 20.0 GHz

20.0 – 26.5 GHz

Magnitude



0.05 – 0.50 GHz

0.50 – 8.0 GHz

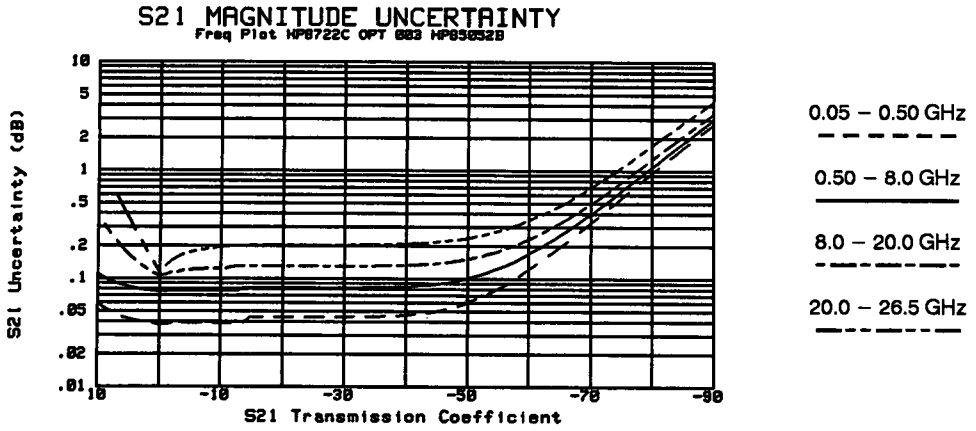
8.0 – 20.0 GHz

20.0 – 26.5 GHz

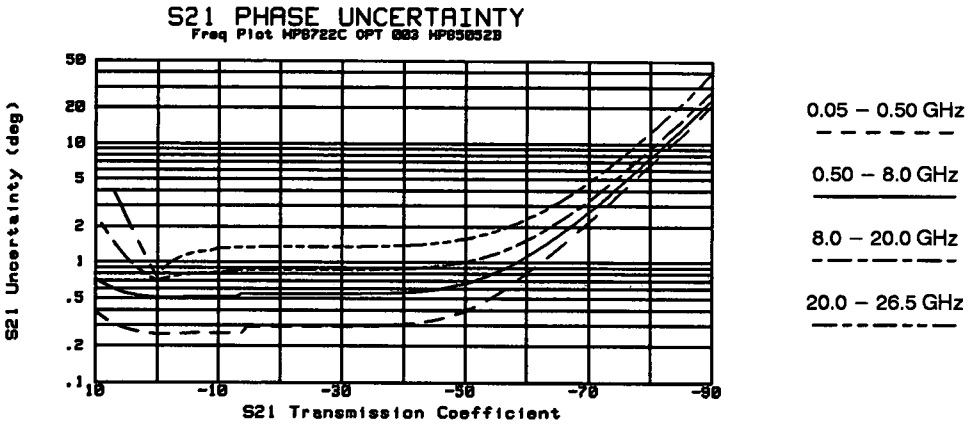
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

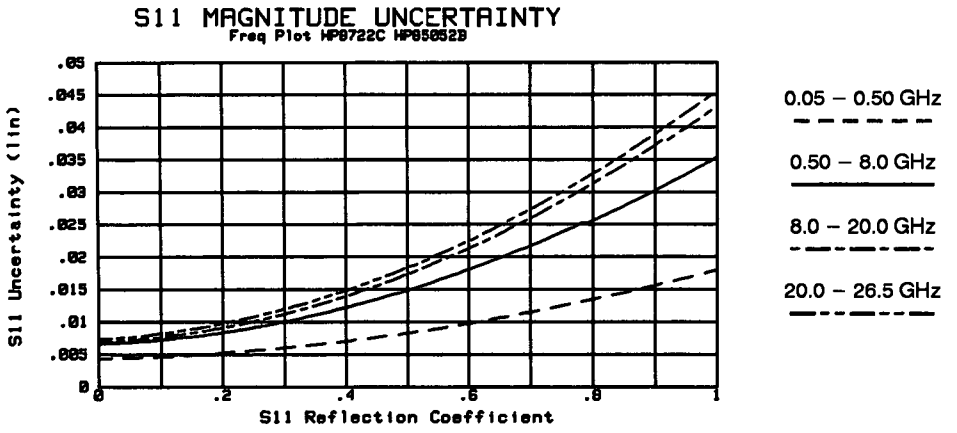


Magnitude

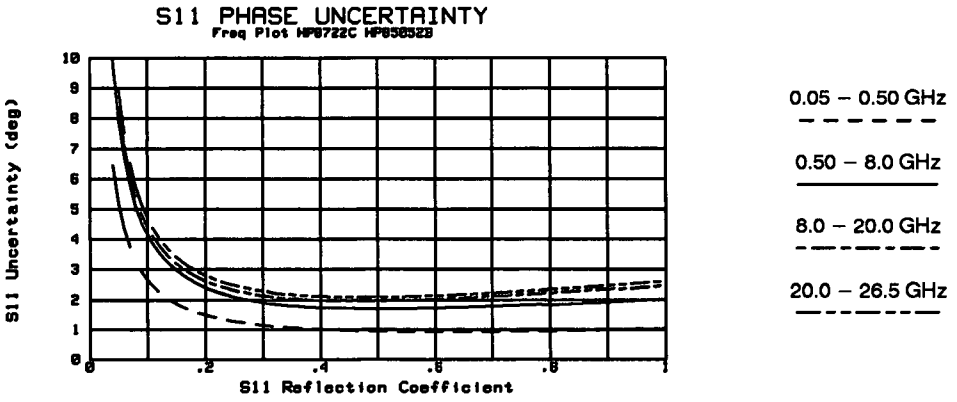


Phase

Reflection Measurements[1] HP 8722C



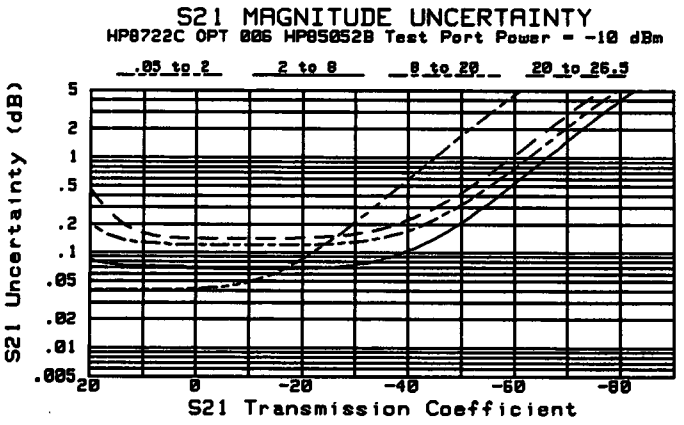
Magnitude



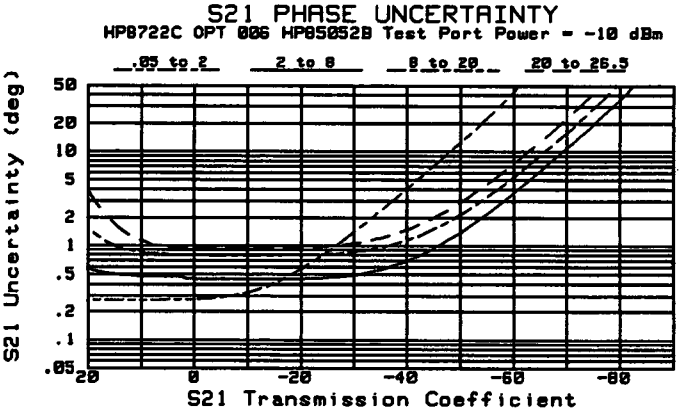
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements (Option 006 only) HP 8722C

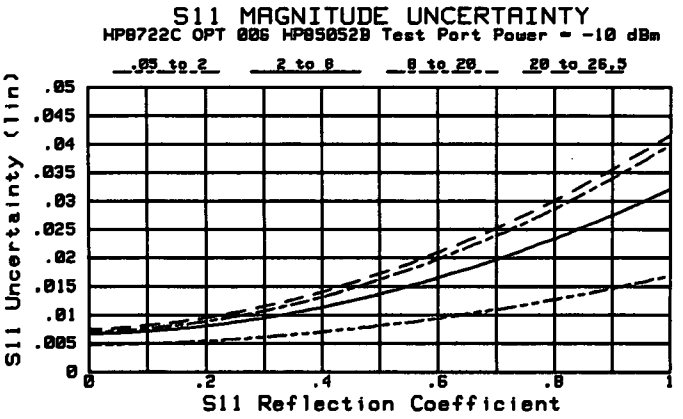


Magnitude

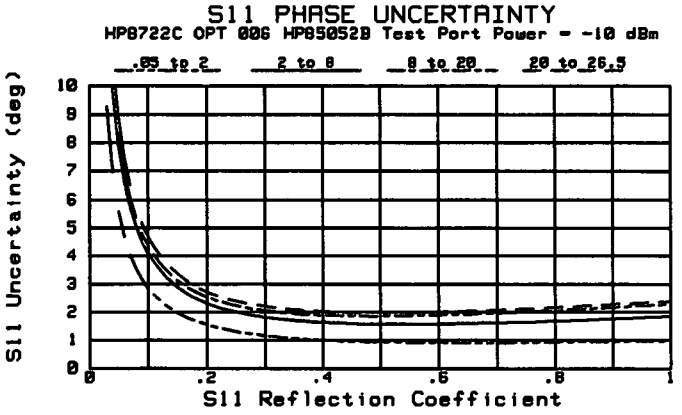


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2–port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

Calibration Kit: HP 85052B (male and female lowband and sliding loads)

Table 3–9. HP 85052B

	Frequency Range			
	.05 – .50 GHz	.50 – 8 GHz	8 – 20 GHz	20 to 26.5 GHz
Directivity	48 dB	44 dB	44 dB	44 dB
Source Match	39 dB	32 dB	30 dB	30 dB
Load Match	46 dB	39 dB	38 dB	38 dB
Reflection Tracking	.011 dB	.036 dB	.038 dB	.040 dB
Transmission Tracking	.015 dB	.056 dB	.092 dB	.112 dB

1. Crosstalk, after an isolation calibration, is no higher than the system noise floor and can be ignored.

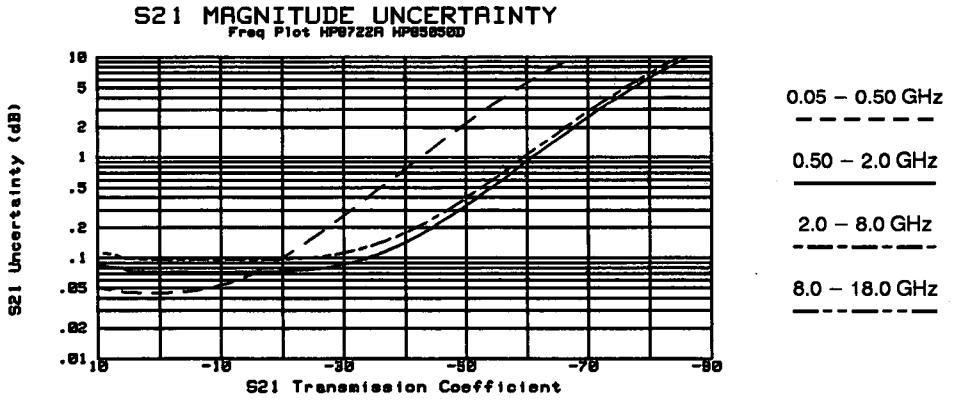
7 MM SYSTEM SPECIFICATIONS

DEVICES WITH 7 MM CONNECTORS

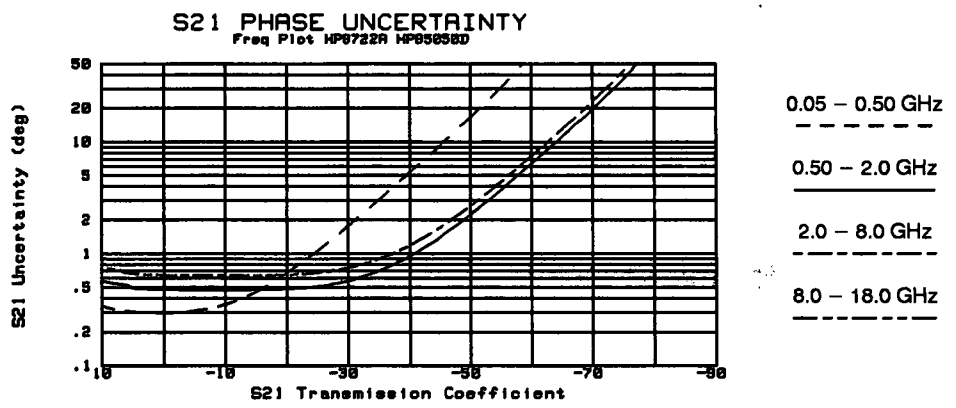
Measurement Uncertainty: HP 85050D Calibration Kit

The following graphs show total worst case measurement uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85050D 7 mm calibration kit, HP 85135D cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 7 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85051B verification kit.

Transmission Measurements[2] HP 8722A



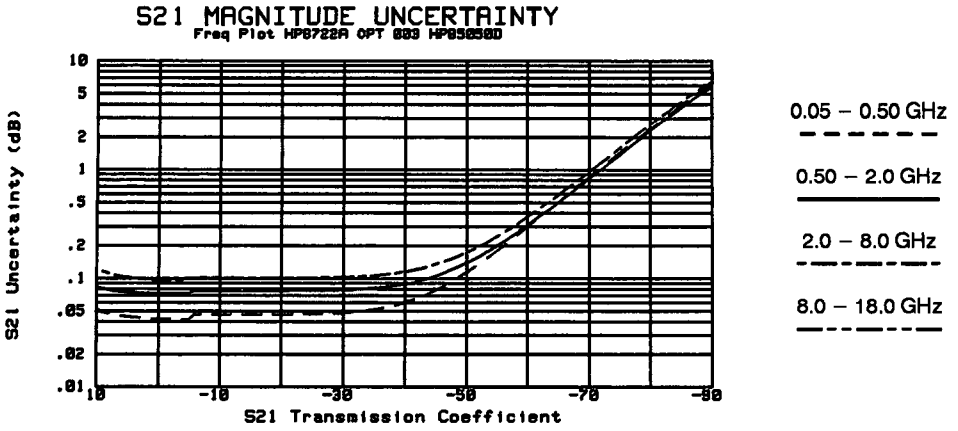
Magnitude



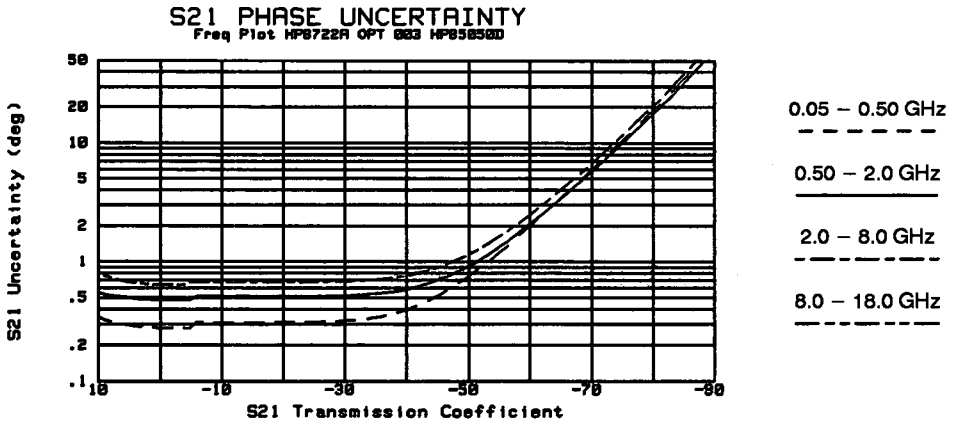
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

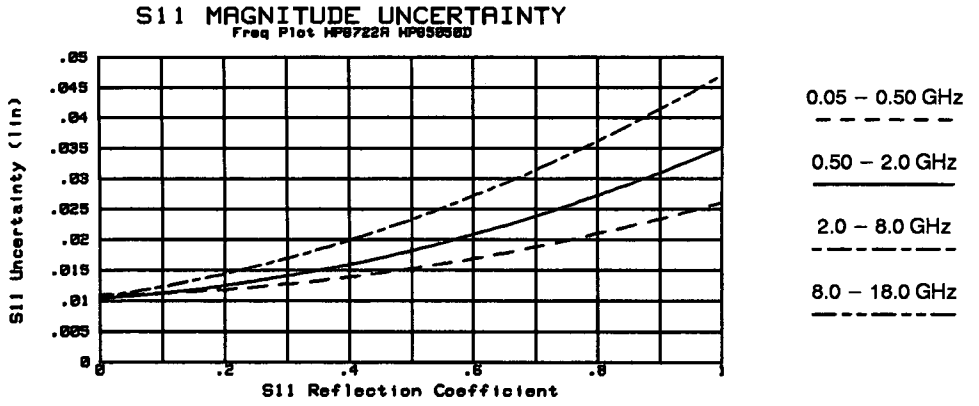


Magnitude

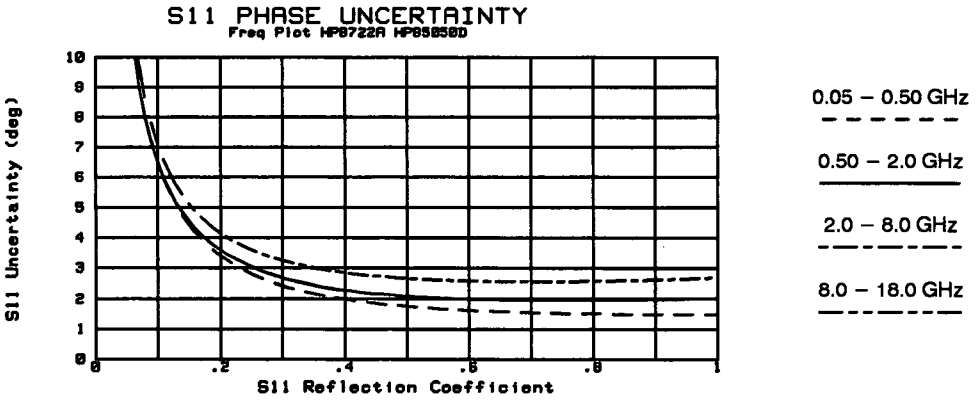


Phase

Reflection Measurements[1] HP 8722A



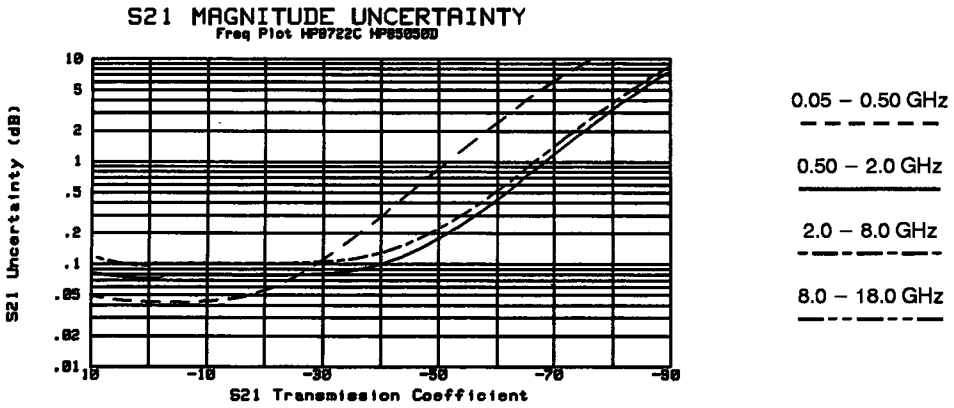
Magnitude



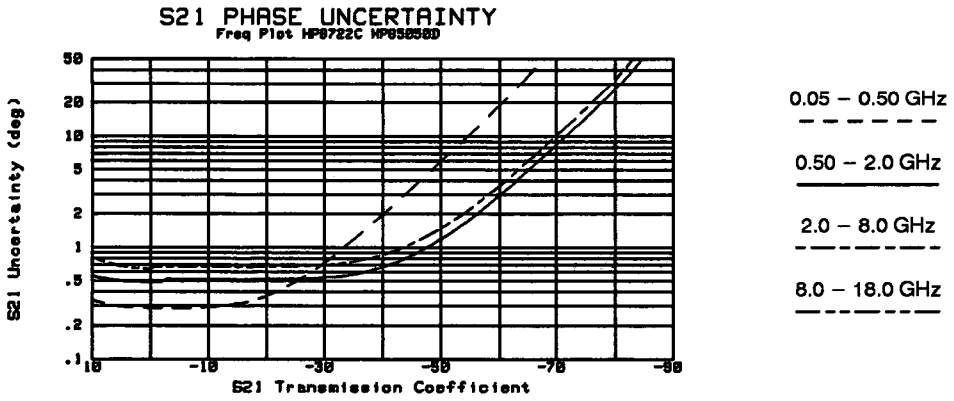
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C



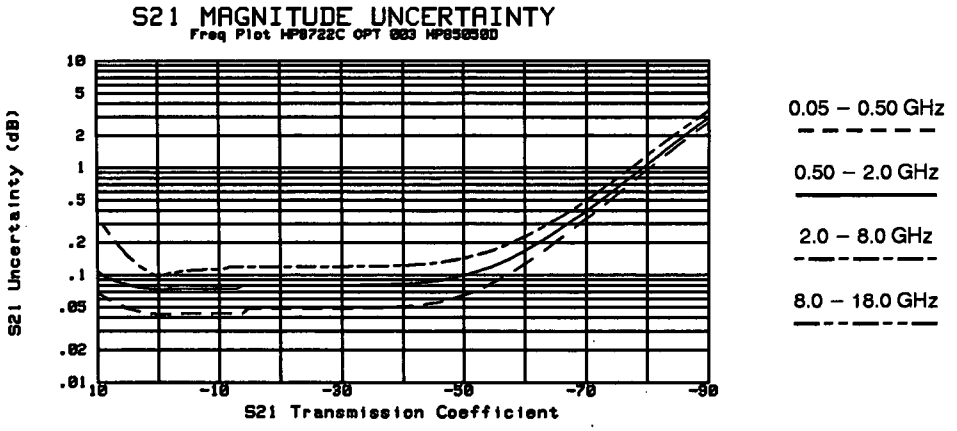
Magnitude



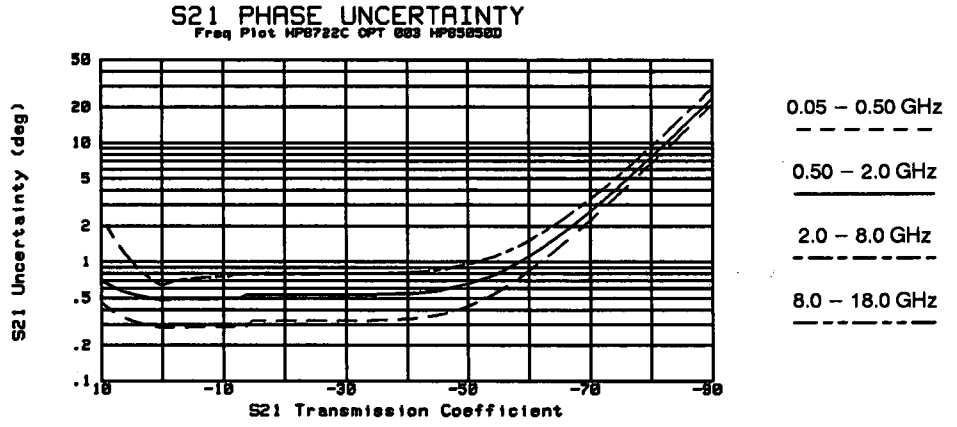
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

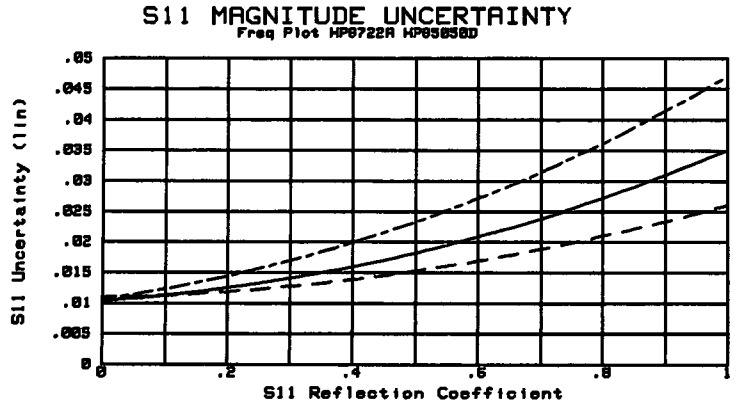


Magnitude

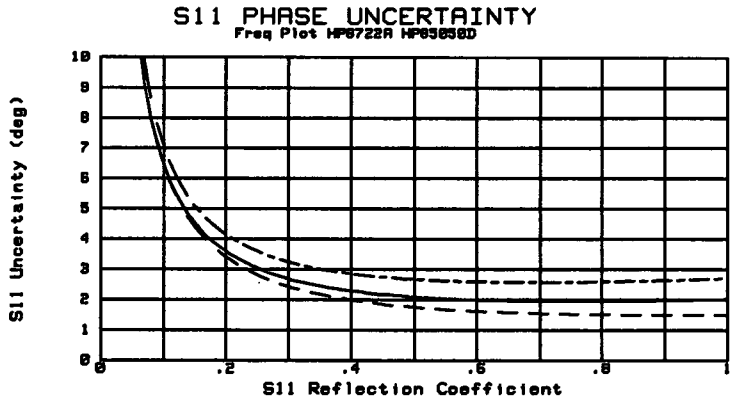


Phase

Reflection Measurements[1] HP 8722C

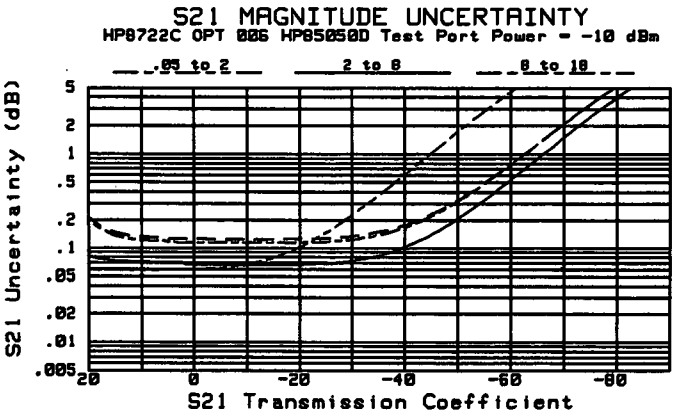


Magnitude

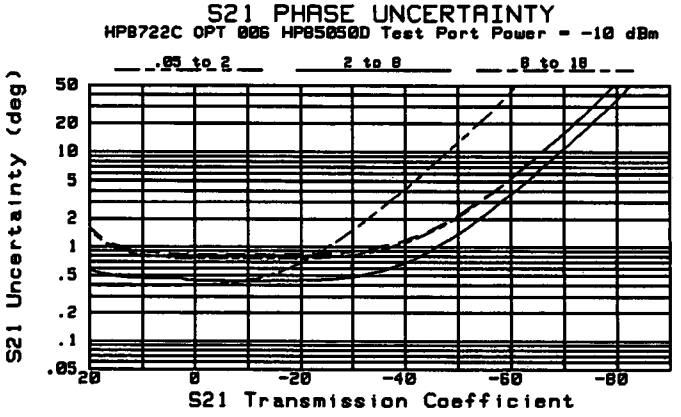


Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

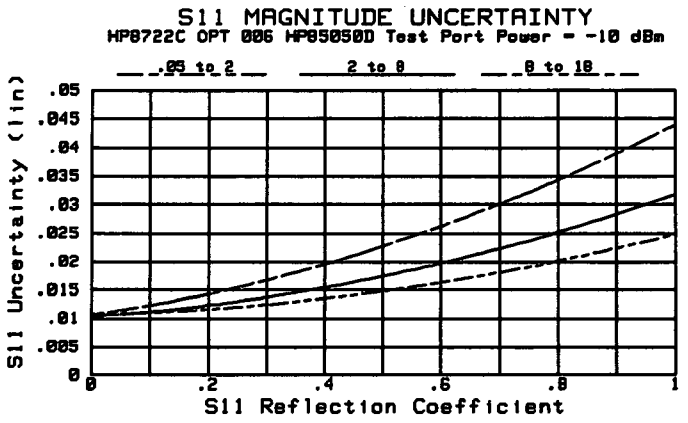


Magnitude

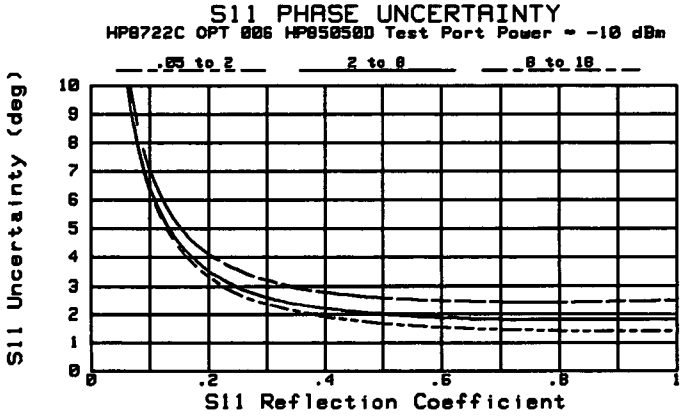


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2-port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

Calibration Kit: HP 85050D (broadband precision fixed load)

Table 3-10. HP 85050D

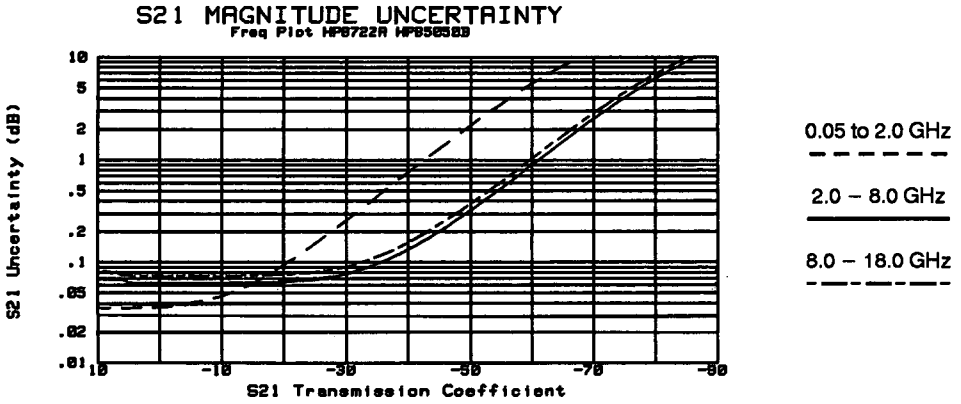
	Frequency Range		
	.050 to 2 GHz	**2 to 8 GHz**	**8 to 18 GHz**
Directivity	40 dB	40 dB	40 dB
Source Match	38 dB	34 dB	32 dB
Load Match	40 dB	37 dB	36 dB
Reflection Tracking	.015 dB	.054 dB	.107 dB
Transmission Tracking	.019 dB	.053 dB	.083 dB

1. Crosstalk after an isolation calibration, is no higher than the system noise floor and can be ignored.

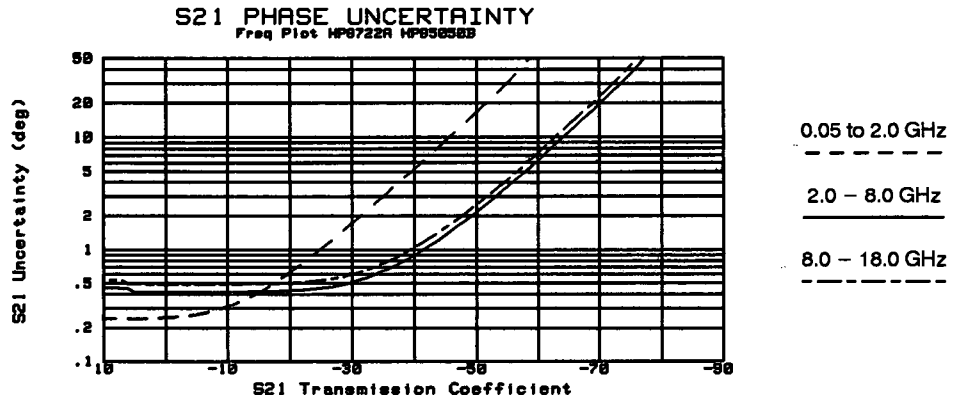
Measurement Uncertainty: 85050B Calibration Kit

The following graphs show total worst case measurement uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85050B 7 mm calibration kit, HP 85135D cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 7 mm connector repeatability, noise, and switch repeatability.[1] Specific points on the graphs are verified by measuring the devices in the HP 85051B verification kit.

Transmission Measurements[2] HP 8722A



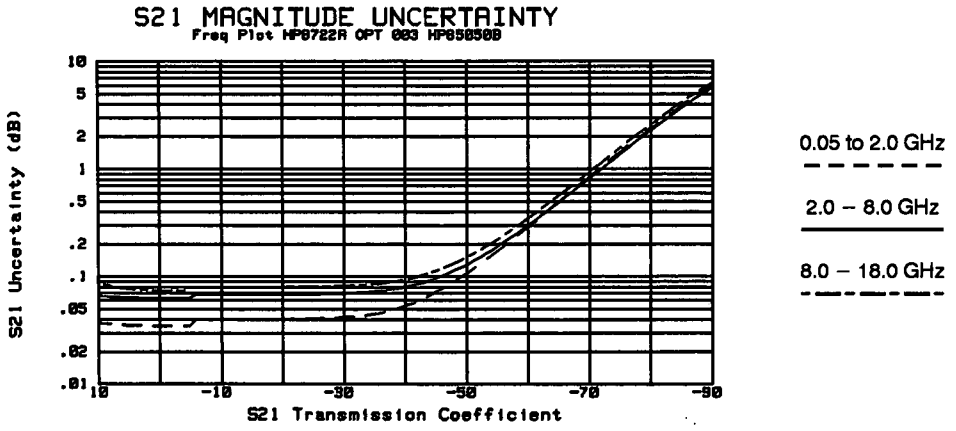
Magnitude



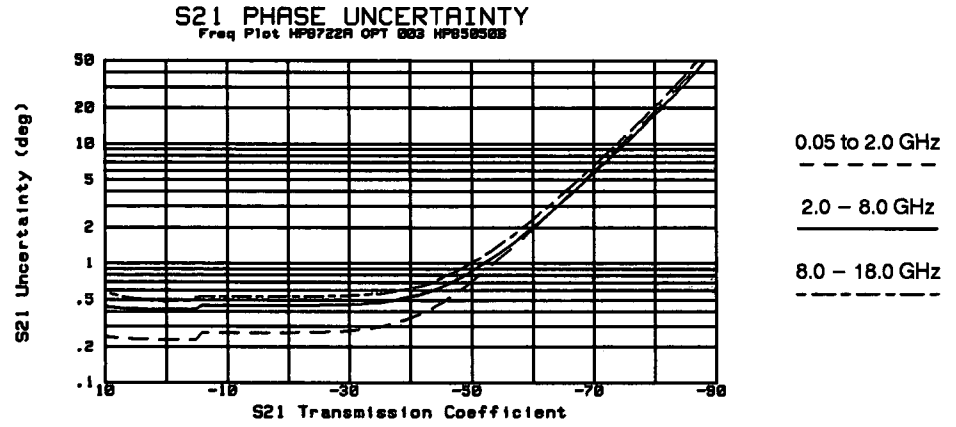
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

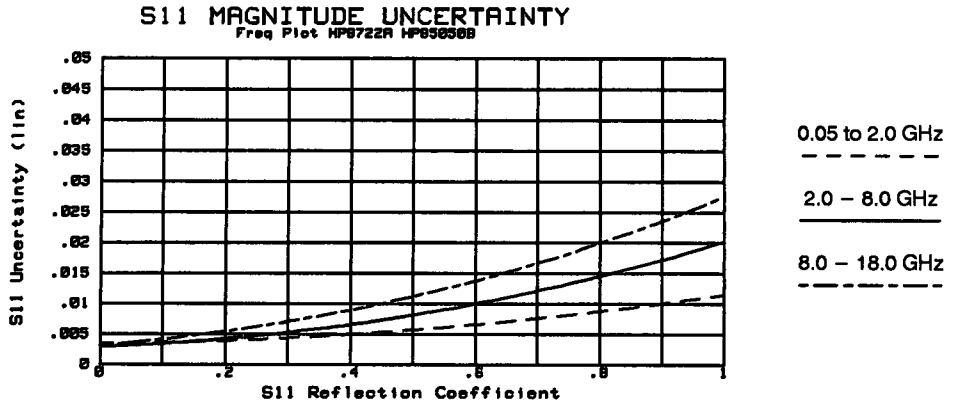


Magnitude

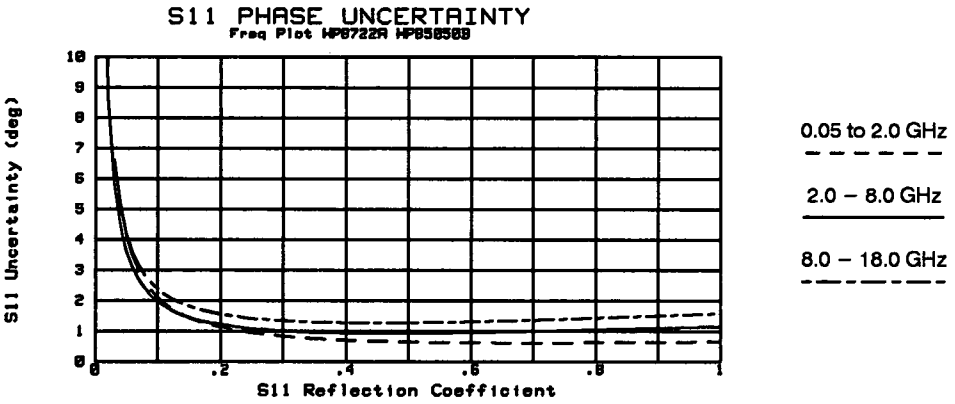


Phase

Reflection Measurement[1] HP 8722A



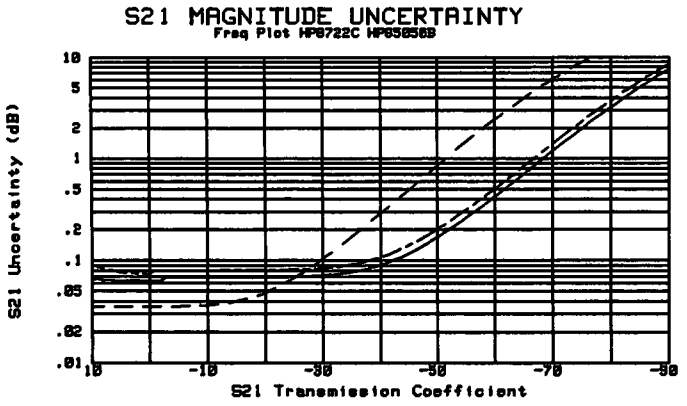
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C

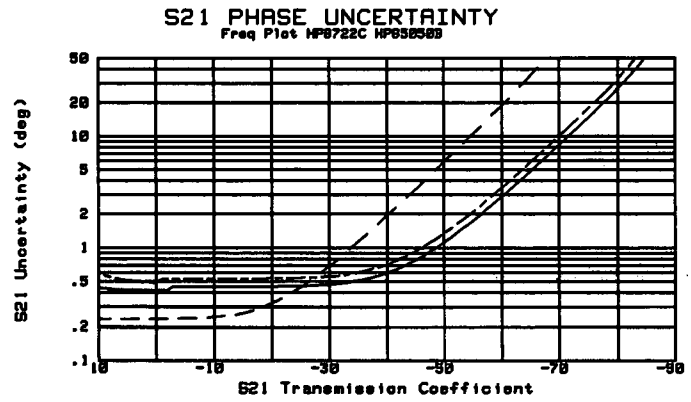


0.05 to 2.0 GHz

2.0 – 8.0 GHz

8.0 – 18.0 GHz

Magnitude



0.05 to 2.0 GHz

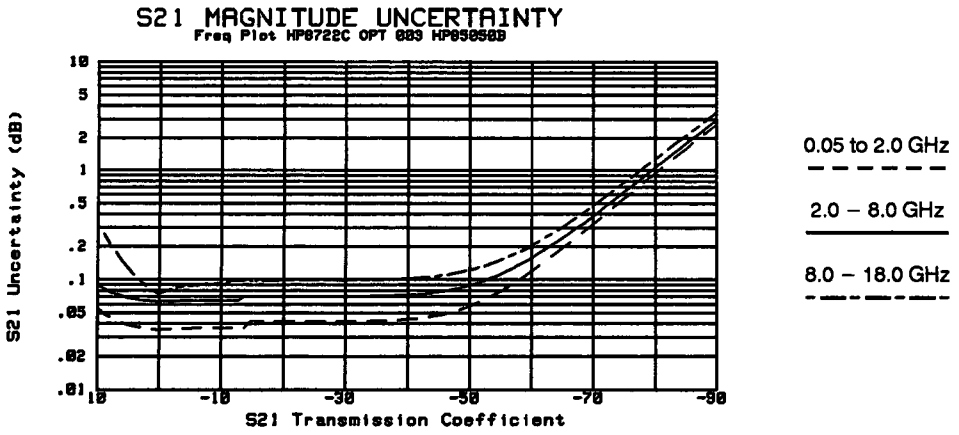
2.0 – 8.0 GHz

8.0 – 18.0 GHz

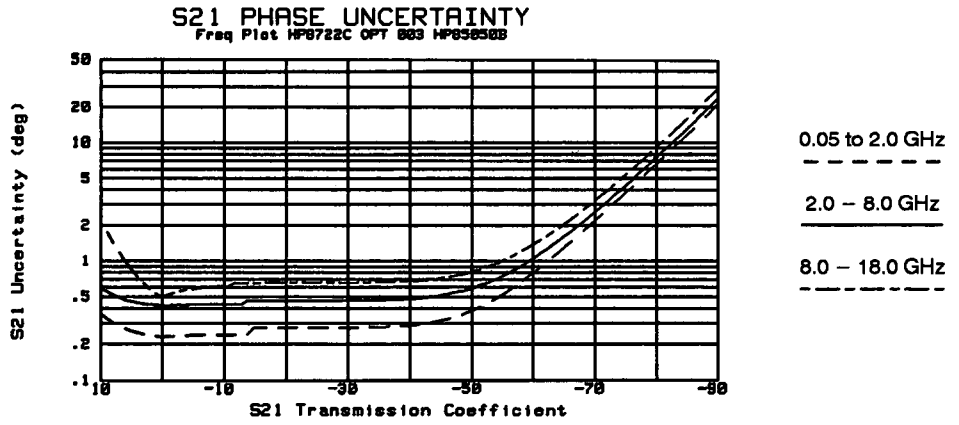
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

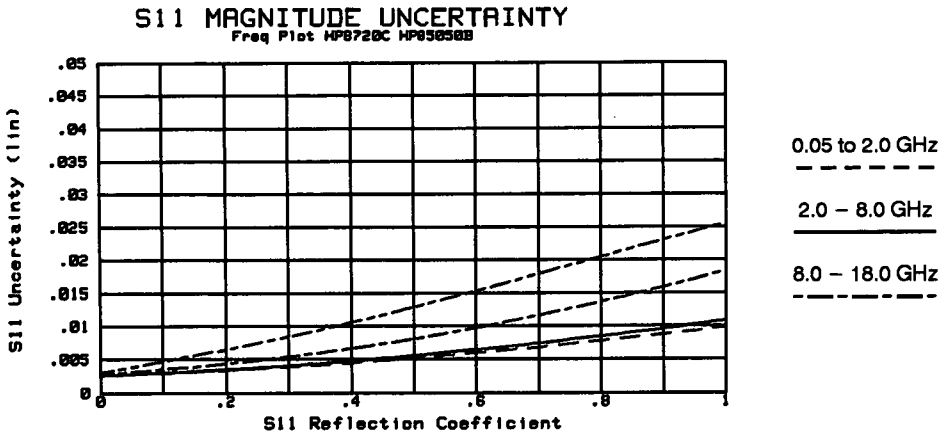


Magnitude

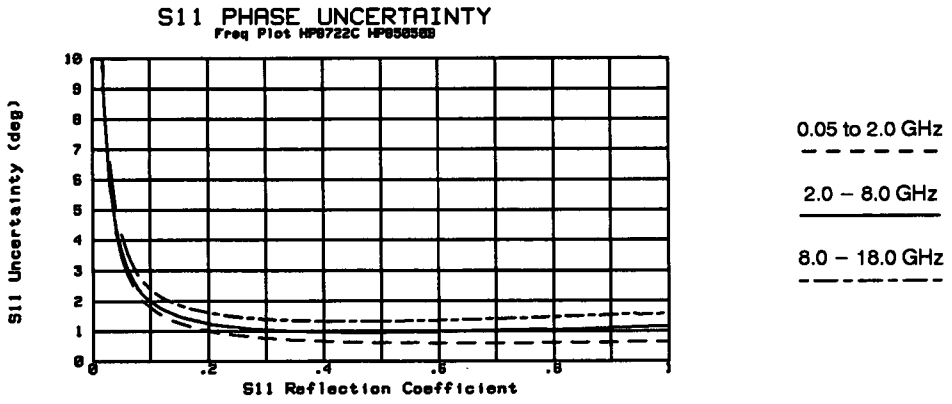


Phase

Reflection Measurements[1] HP 8722C

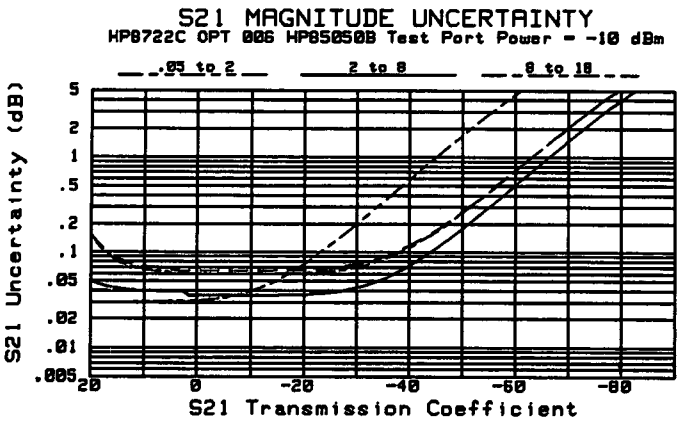


Magnitude

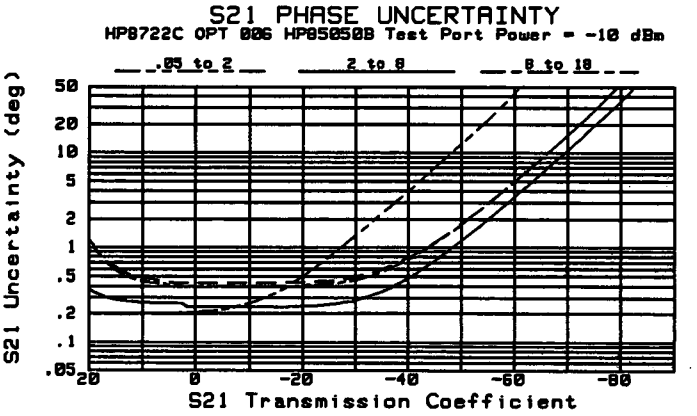


Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

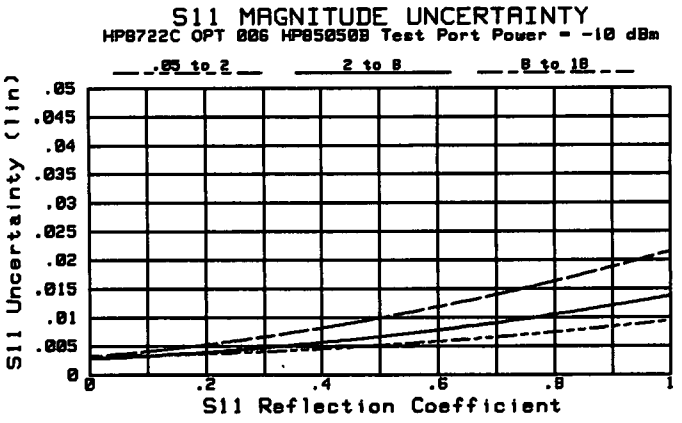


Magnitude

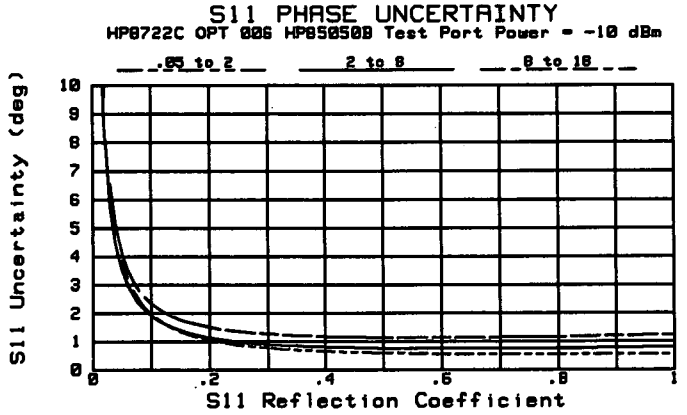


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the residual system performance (including switch repeatability) after accuracy enhancement using a full 2–port measurement calibration (including isolation) with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

Calibration Kit: HP 85050B (lowband and sliding loads)

Table 3–11. HP 85050B

	Frequency Range		
	.050 to 2 GHz	2 to 8 GHz	8 to 18 GHz
Directivity	52 dB	52 dB	52 dB
Source Match	44 dB	37 dB	35 dB
Load Match	48 dB	41 dB	39 dB
Reflection Tracking	.011 dB	.040 dB	.060 dB
Transmission Tracking	.013 dB	.046 dB	.068 dB

1. Crosstalk after an isolation calibration, is no higher than the system noise floor and can be ignored.

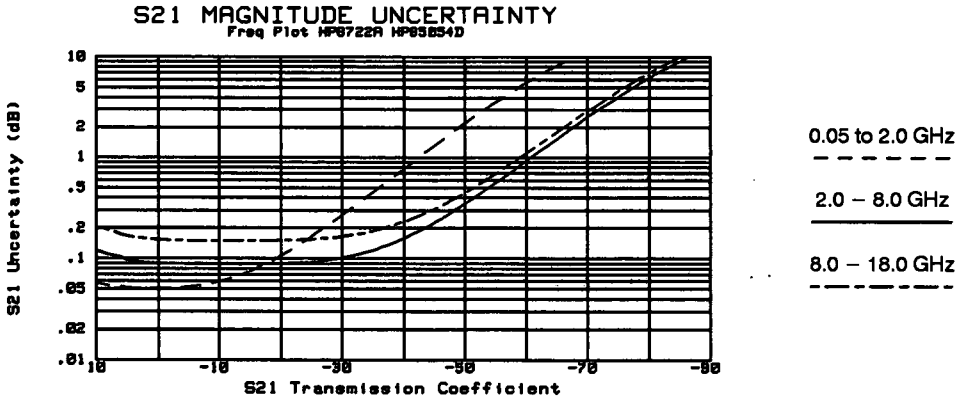
TYPE–N SYSTEM SPECIFICATIONS

DEVICES WITH TYPE–N CONNECTORS

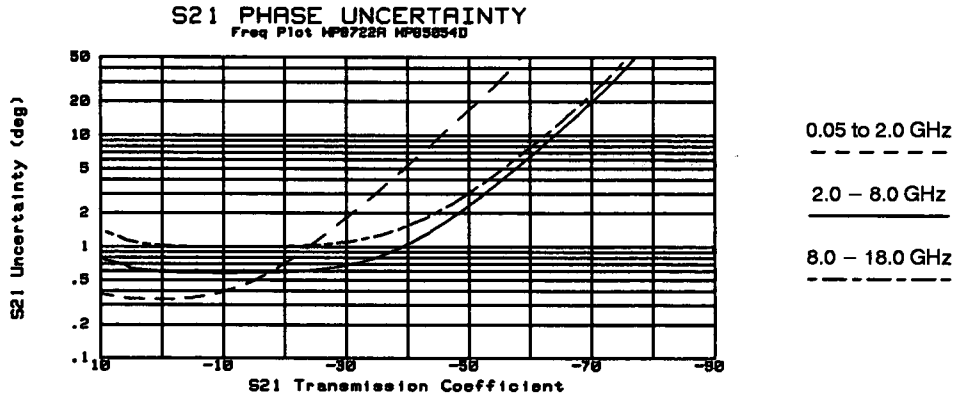
Measurement Uncertainty: HP 85054D Calibration Kit

The following graphs show total worst case measurement uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85054D type–N calibration kit, HP 85135D cable set, and an IF bandwidths of 10 Hz. this includes the residual systematic errors, as well as the system dynamic accuracy, type–N connector repeatability, noise, and switch repeatability.[1] The 85054–60031 and 85054–60032 special 7 mm to type–N adapter sets are used to adapt the 7 mm cable ports to type–N. Specific points on the graphs are verified by measuring the devices in the HP 85055A verification kit.

Transmission Measurements[2] HP 8722A



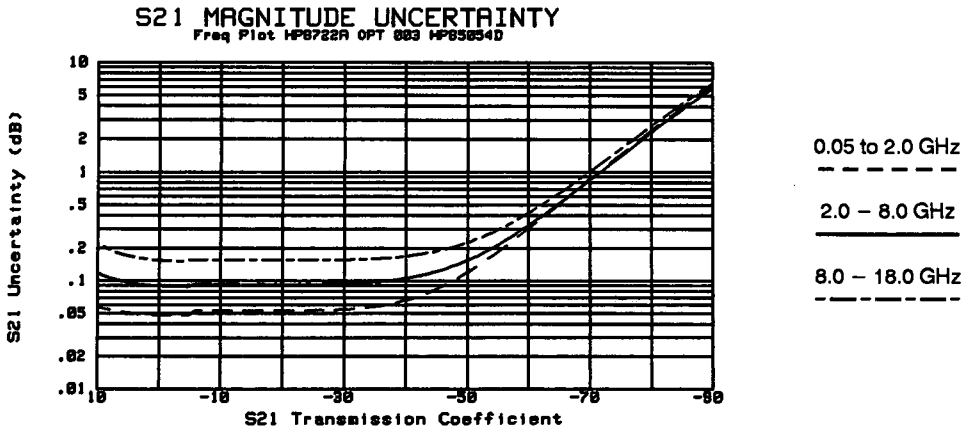
Magnitude



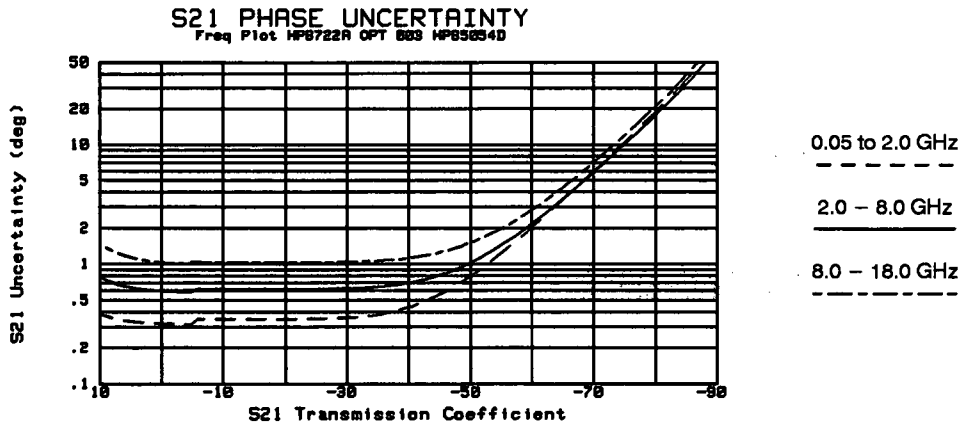
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

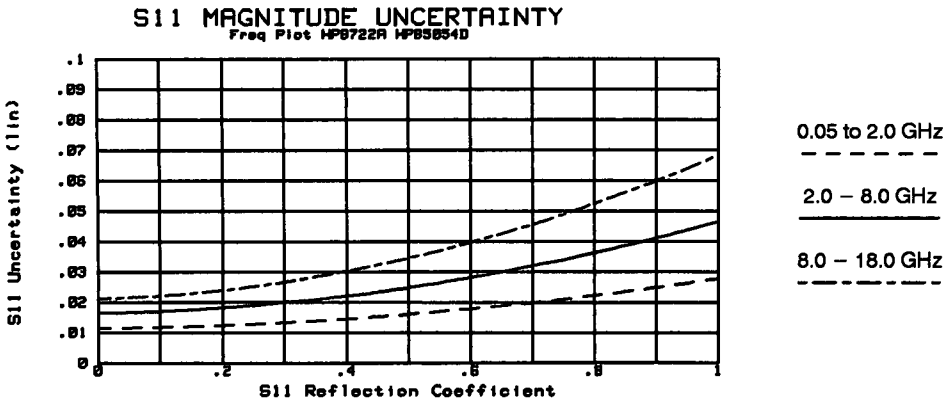


Magnitude

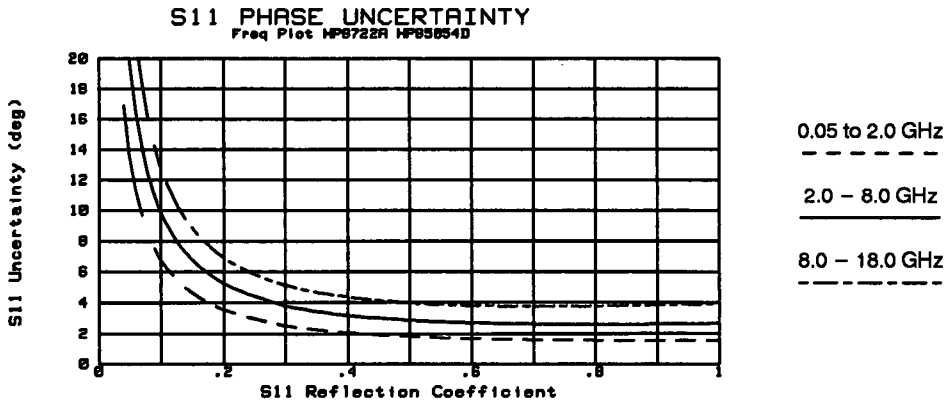


Phase

Reflection Measurements[1] HP 8722A



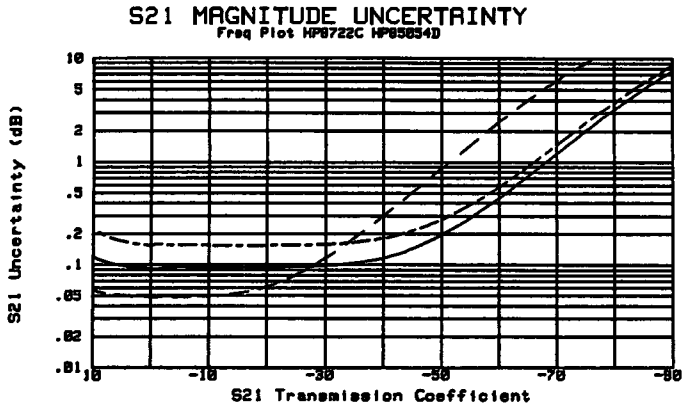
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C

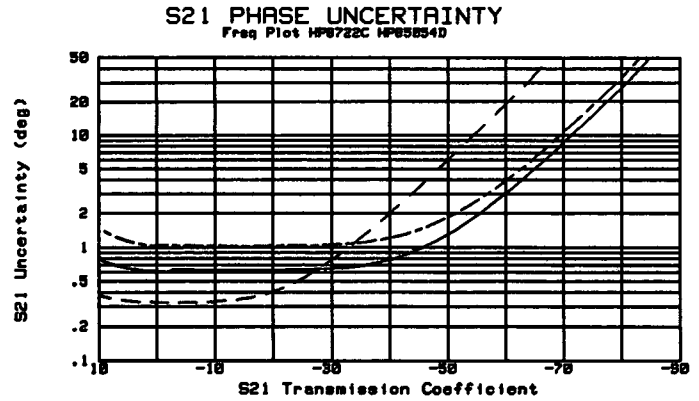


0.05 to 2.0 GHz

2.0 – 8.0 GHz

8.0 – 18.0 GHz

Magnitude



0.05 to 2.0 GHz

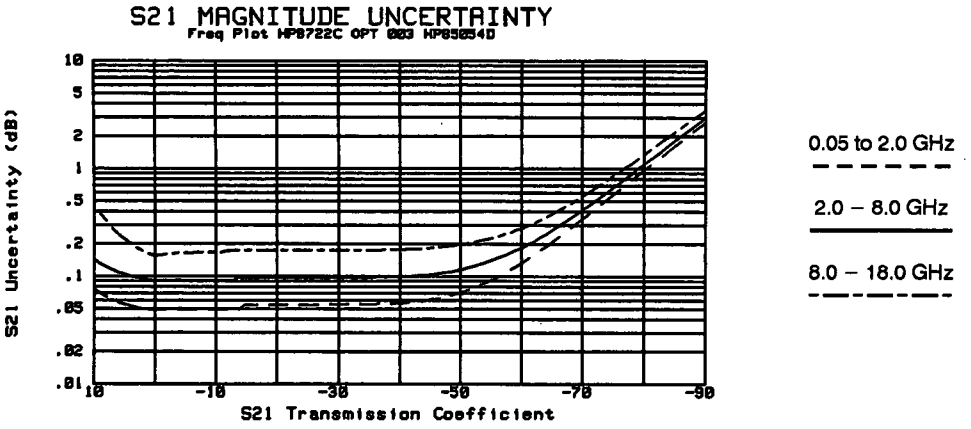
2.0 – 8.0 GHz

8.0 – 18.0 GHz

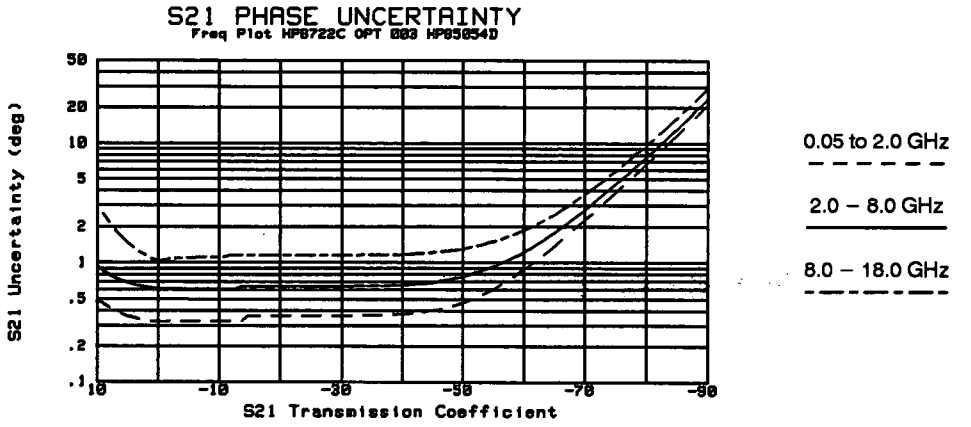
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

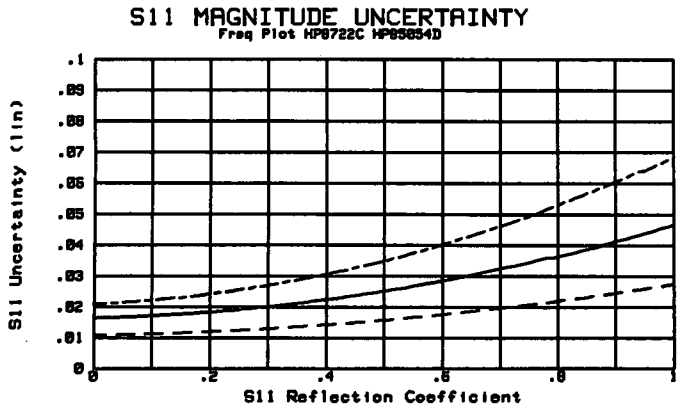


Magnitude



Phase

Reflection Measurements[1] HP 8722C

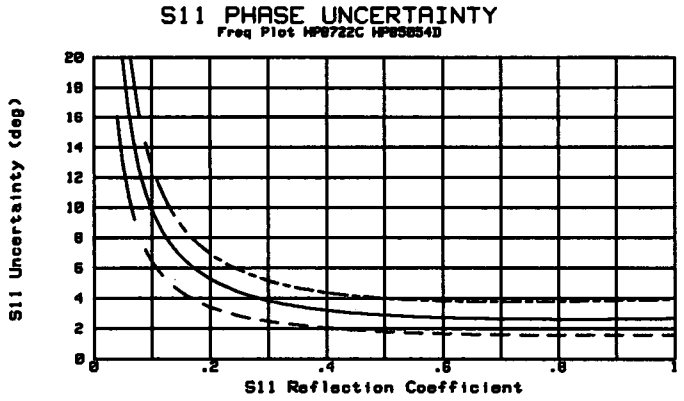


0.05 to 2.0 GHz

2.0 – 8.0 GHz

8.0 – 18.0 GHz

Magnitude



0.05 to 2.0 GHz

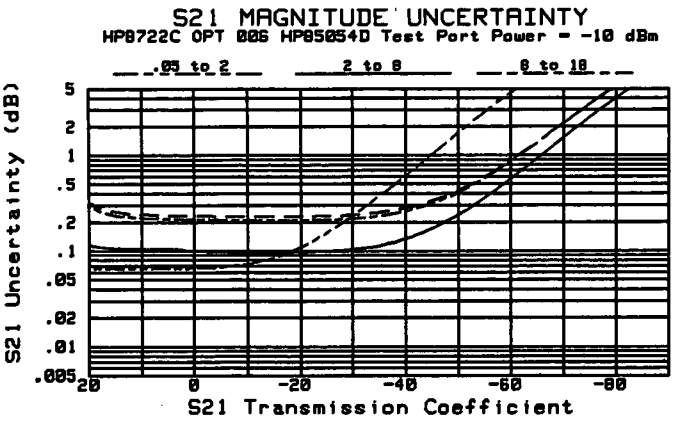
2.0 – 8.0 GHz

8.0 – 18.0 GHz

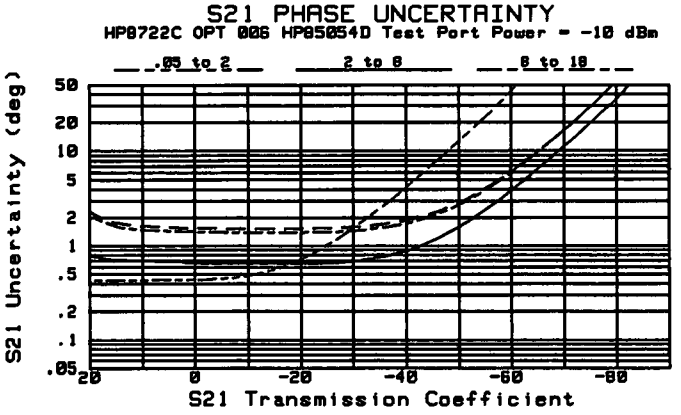
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements (Option 006 only) HP 8722C

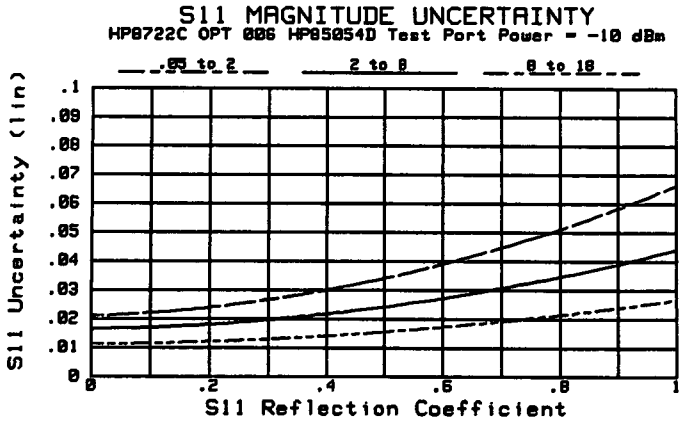


Magnitude

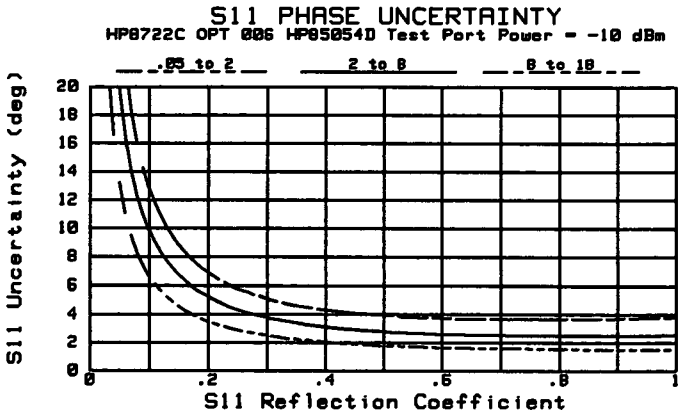


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show one residual system performance (including switch repeatability) after accuracy enhancement using a full 2−port measurement calibration (including isolation) with an HP 85054D type−N calibration kit, and an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23°±3°C.

Calibration Kit: HP 85054D (male and female broadband precision fixed load)

Table 3−12. HP 85054D

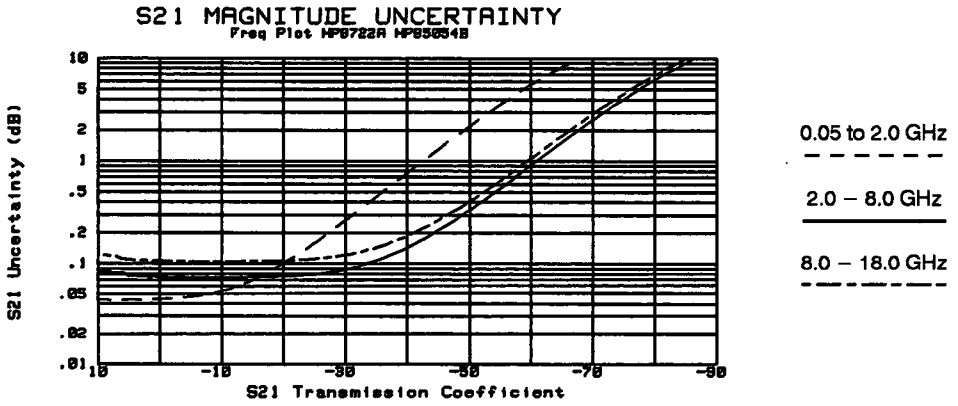
	Frequency Range		
	.050 to 2 GHz	2 to 8 GHz	8 to 18 GHz
Directivity	40 dB	36 dB	34 dB
Source Match	38 dB	32 dB	28 dB
Load Match	39 dB	34 dB	32 dB
Reflection Tracking	.011 dB	.037 dB	.046 dB
Transmission Tracking	.02 dB	.065 dB	.124 dB

1. Crosstalk after an isolation calibration, is no higher than the system noise floor and can be ignored.

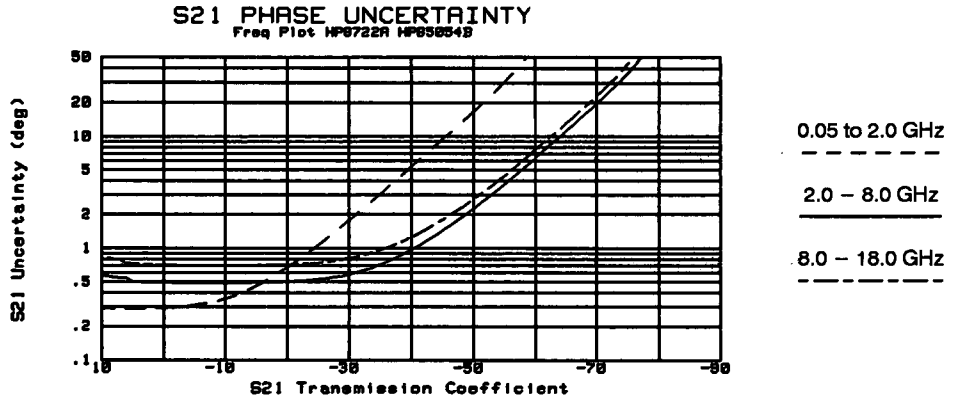
Measurement Uncertainty: HP 85054B Calibration Kit

The following graphs show total worst case measurement uncertainty for the network analyzer after accuracy enhancement using a full 2–port measurement calibration (including isolation) with the HP 85054B type–N calibration kit, HP 85135D cable set, and an IF bandwidths of 10 Hz. this includes the residual systematic errors, as well as the system dynamic accuracy, type–N connector repeatability, noise, and switch repeatability.[1] The 85054–60031 and 85054–60032 special 7 mm to type–N adapter sets are used to adapt the 7 mm cable ports to type–N. Specific points on the graphs are verified by measuring the devices in the HP 85055A verification kit.

Transmission Measurements[2] HP 8722A



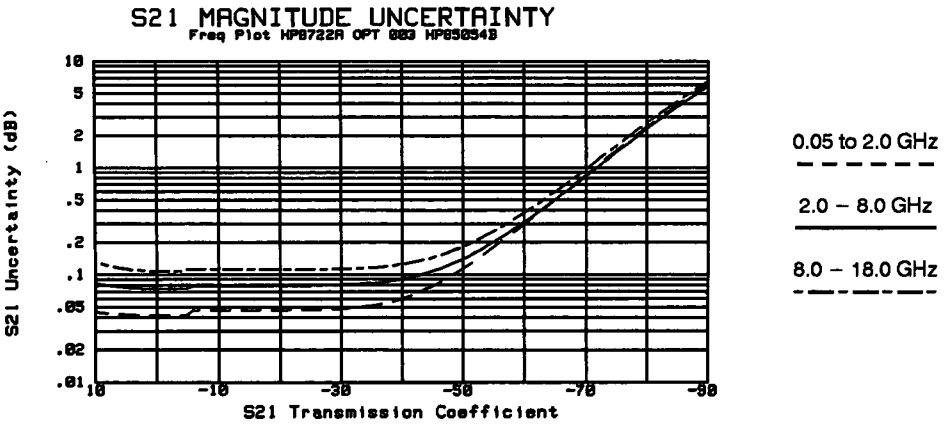
Magnitude



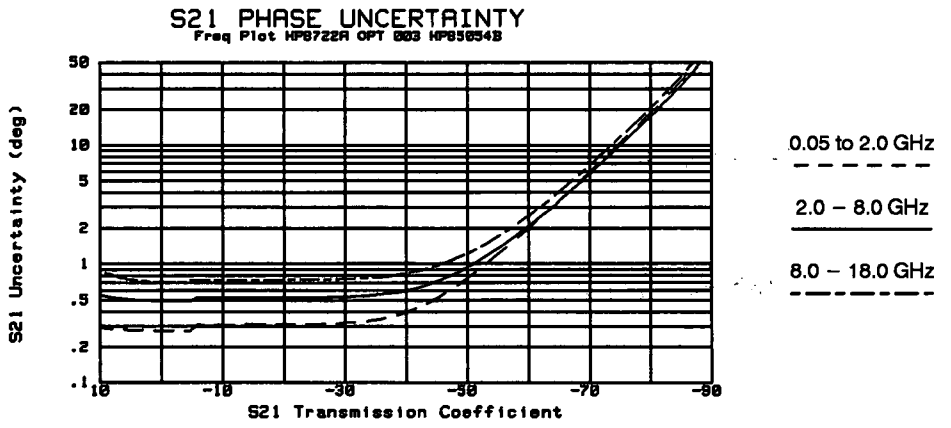
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

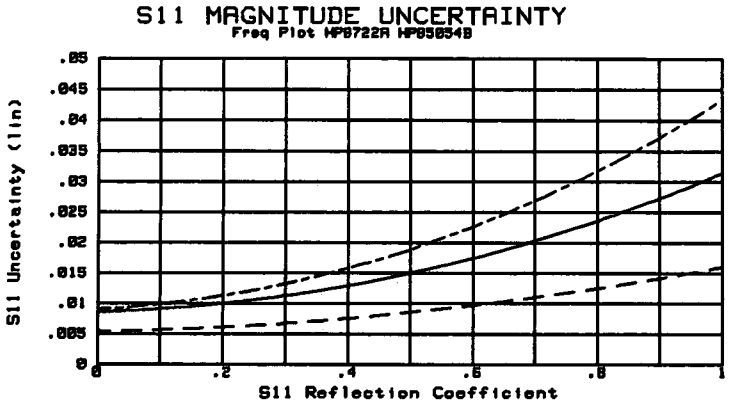


Magnitude

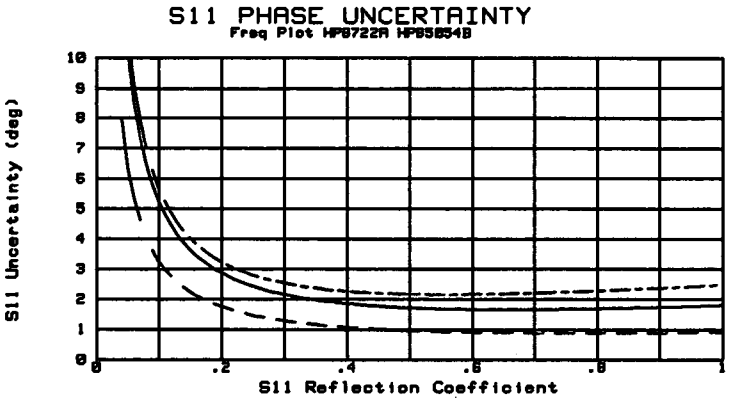


Phase

Reflection Measurements[1] HP 8722A



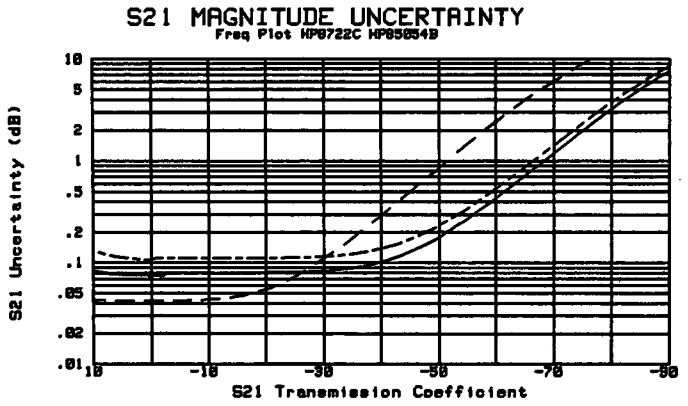
Magnitude



Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements[1] HP 8722C

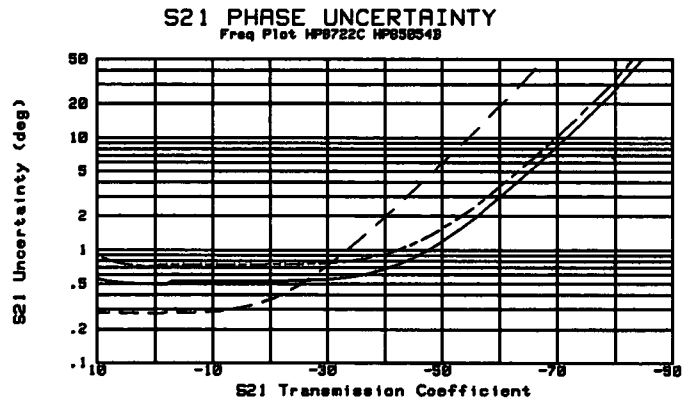


0.05 to 2.0 GHz

2.0 – 8.0 GHz

8.0 – 18.0 GHz

Magnitude



0.05 to 2.0 GHz

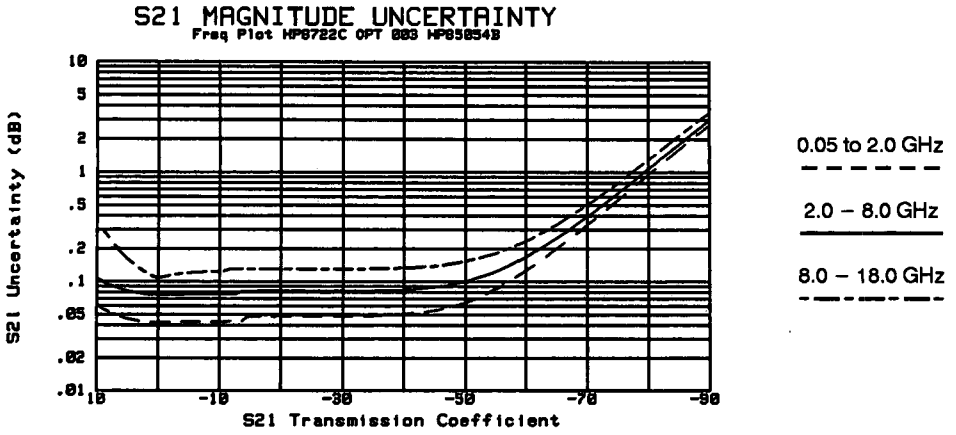
2.0 – 8.0 GHz

8.0 – 18.0 GHz

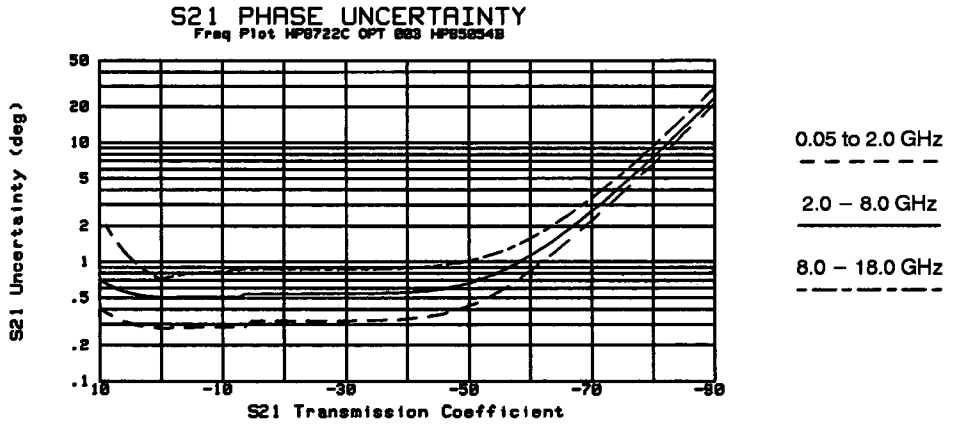
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

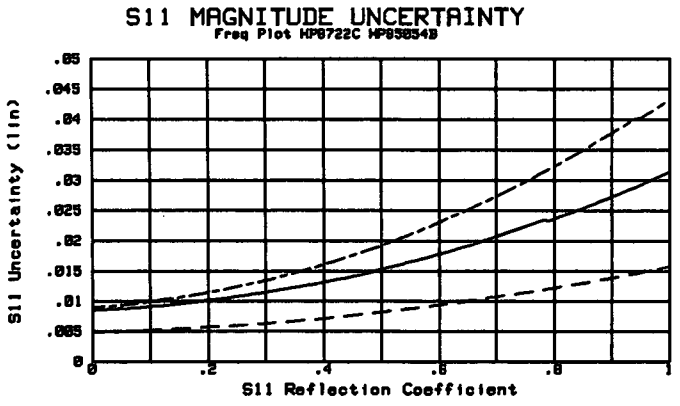


Magnitude



Phase

Reflection Measurements[1] HP 8722C

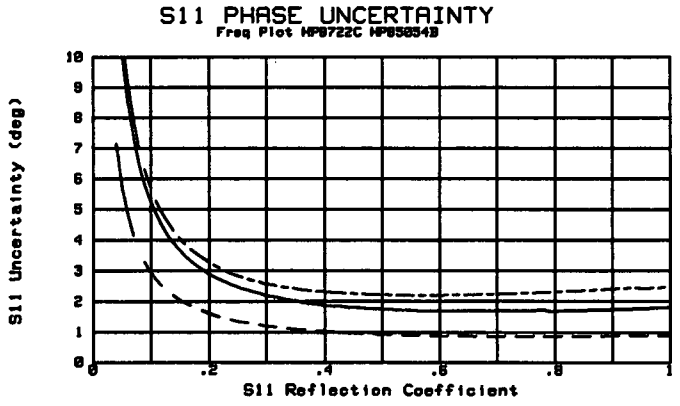


0.05 to 2.0 GHz

2.0 – 8.0 GHz

8.0 – 18.0 GHz

Magnitude



0.05 to 2.0 GHz

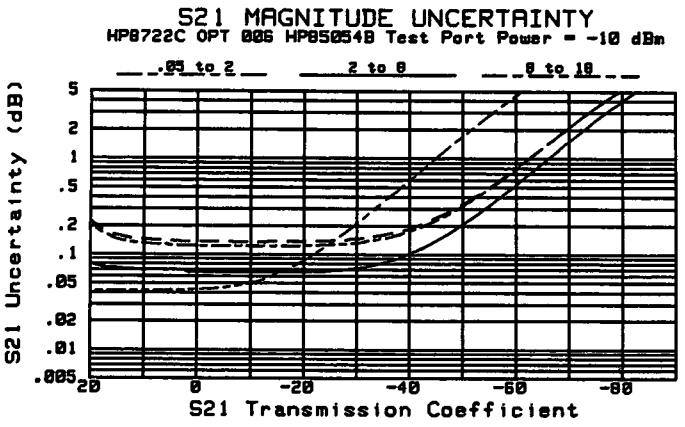
2.0 – 8.0 GHz

8.0 – 18.0 GHz

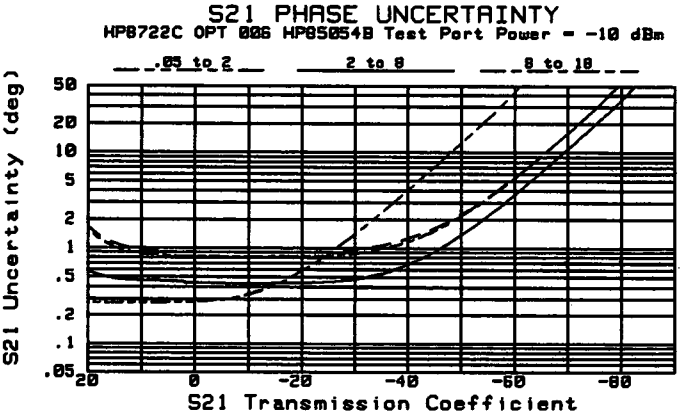
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

Transmission Measurements (Option 006 only) HP 8722C

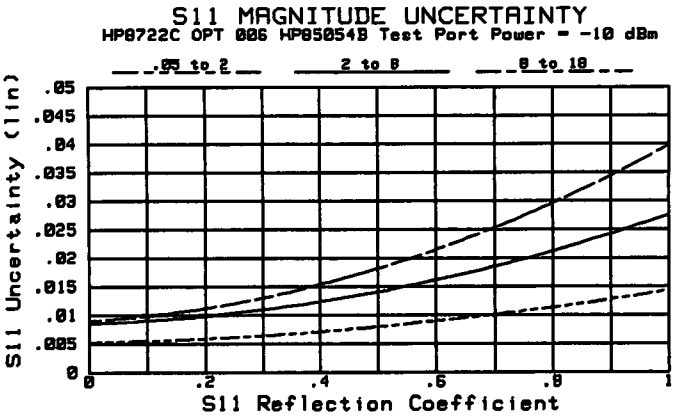


Magnitude

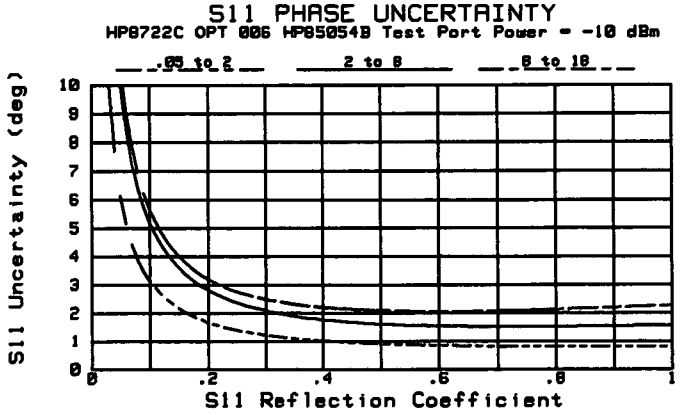


Phase

Reflection Measurements (Option 006 only) HP 8722C



Magnitude



Phase

Measurement Port Specifications[1]

The following specifications show the typical residual system performance (including switch repeatability) after accuracy enhancement using a full 2-port measurement calibration (including isolation) with an HP 85054D type-N calibration kit, and an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23°±3°C.

Calibration Kit: HP 85054B (male and female lowband and sliding loads)

Table 3-13. HP 85054B

	Frequency Range		
	.050 to 2 GHz	2 to 8 GHz	8 to 18 GHz
Directivity	48 dB	42 dB	42 dB
Source Match	42 dB	34 dB	31 dB
Load Match	46 dB	38 dB	37 dB
Reflection Tracking	.011 dB	.036 dB	.038 dB
Transmission Tracking	.014 dB	.052 dB	.088 dB

1. Crosstalk after an isolation calibration, is no higher than the system noise floor and can be ignored.

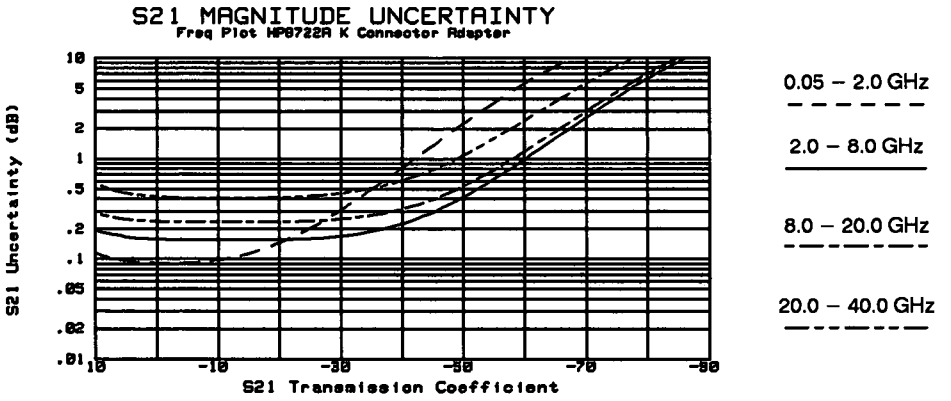
2.92 MM SYSTEM CHARACTERISTICS

DEVICES WITH 2.92 MM CONNECTORS (K CONNECTOR)

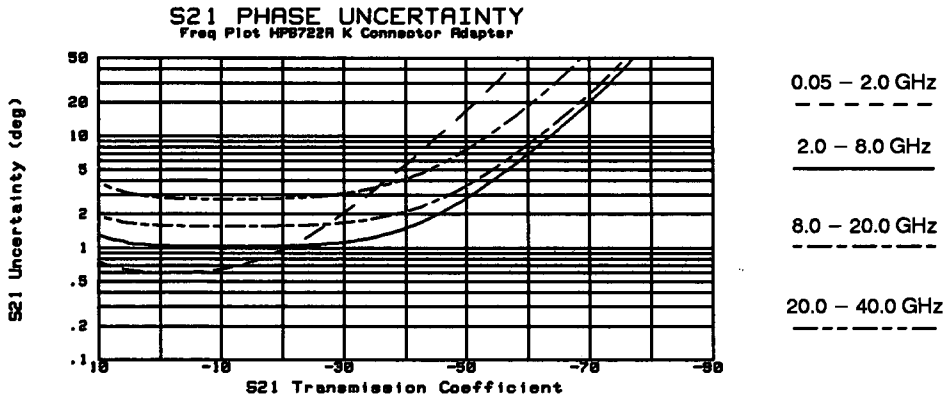
Measurement Uncertainty: HP 85056K Calibration Kit

The following graphs show typical total worst case uncertainty for the network analyzer after accuracy enhancement using a full 2-port measurement calibration (including isolation) with the HP 85056K calibration kit, HP 85133D cable set, and an IF bandwidth of 10 Hz. This includes the residual systematic errors, as well as the system dynamic accuracy, 2.4/2.92 adapter influence, 2.92 mm connector repeatability, noise, and switch repeatability.[1]

Transmission Measurements[2] HP 8722A



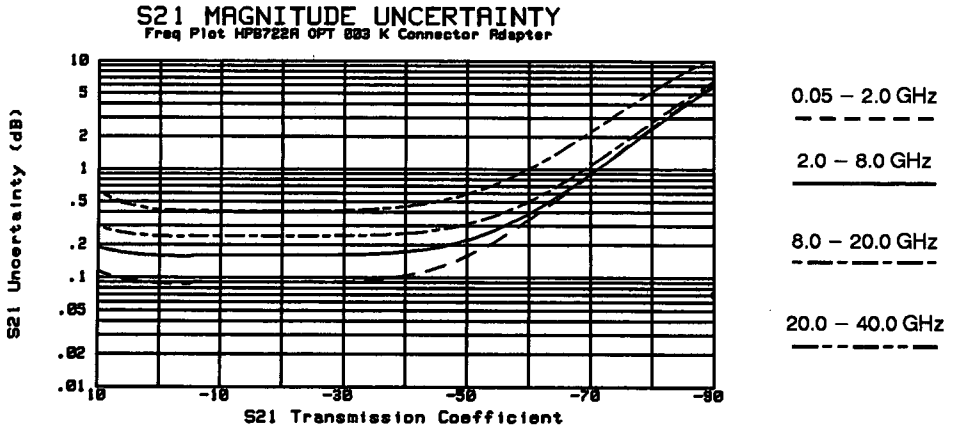
Magnitude



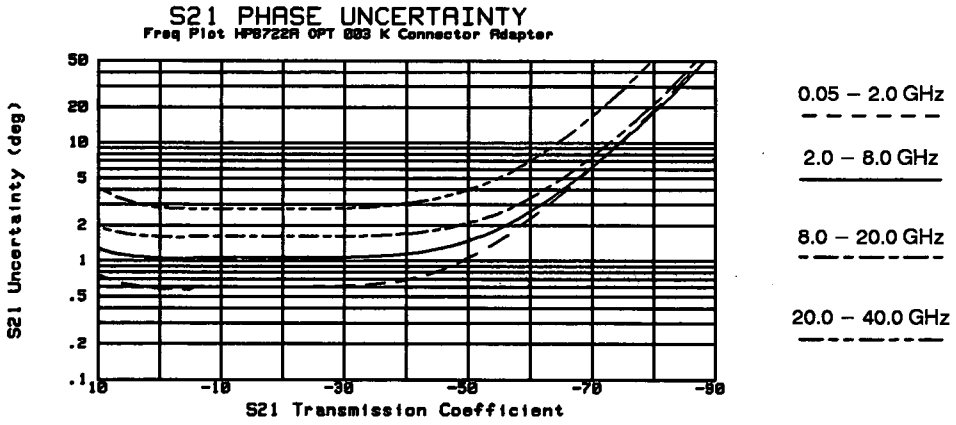
Phase

1. Cable stability and system drift are not included.
2. The graphs for transmission measurements assume a well-matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722A

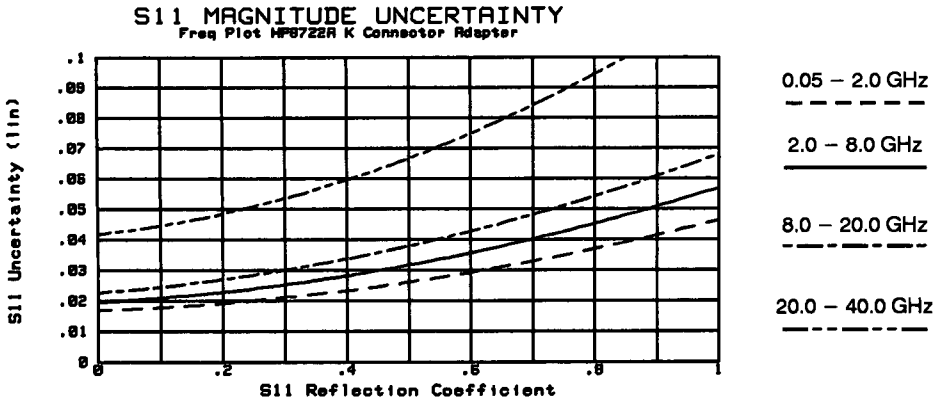


Magnitude

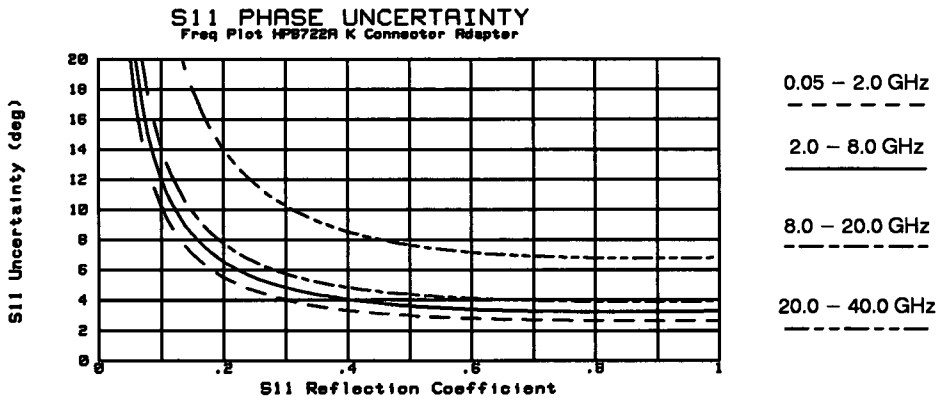


Phase

Reflection Measurements[1] HP 8722A



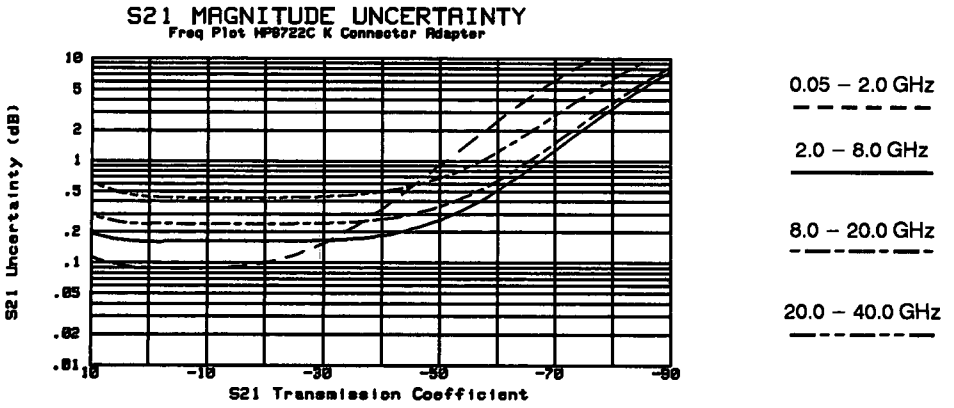
Magnitude



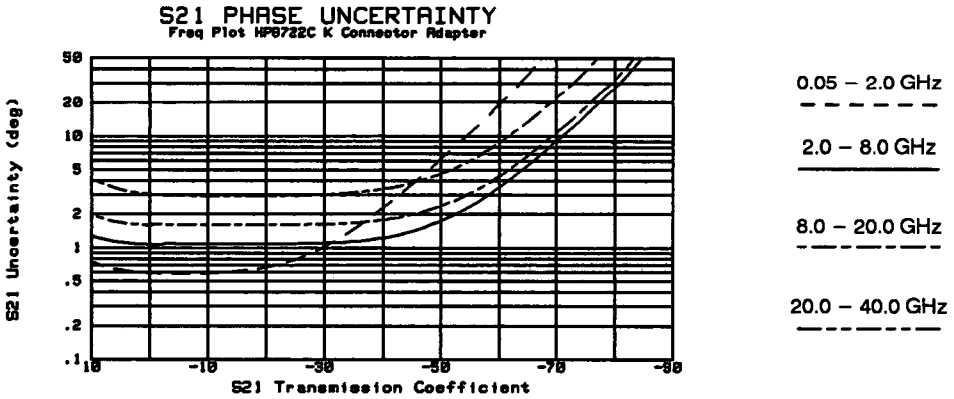
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one-port device.

Transmission Measurements[1] HP 8722C



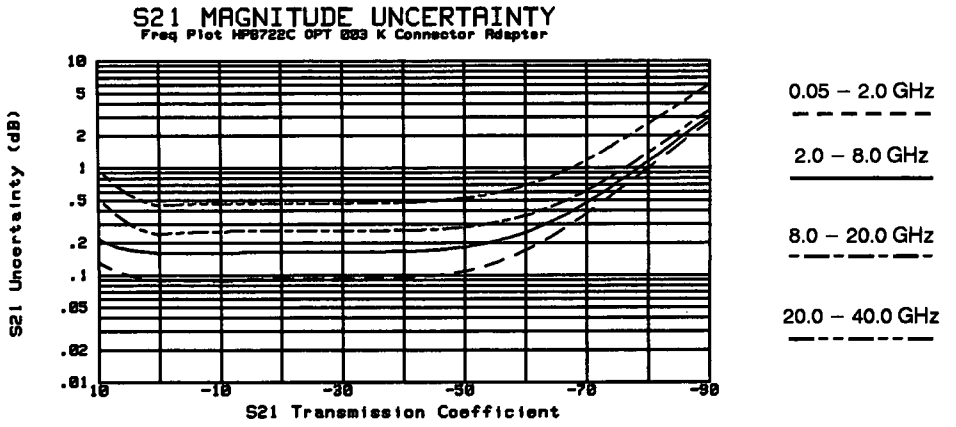
Magnitude



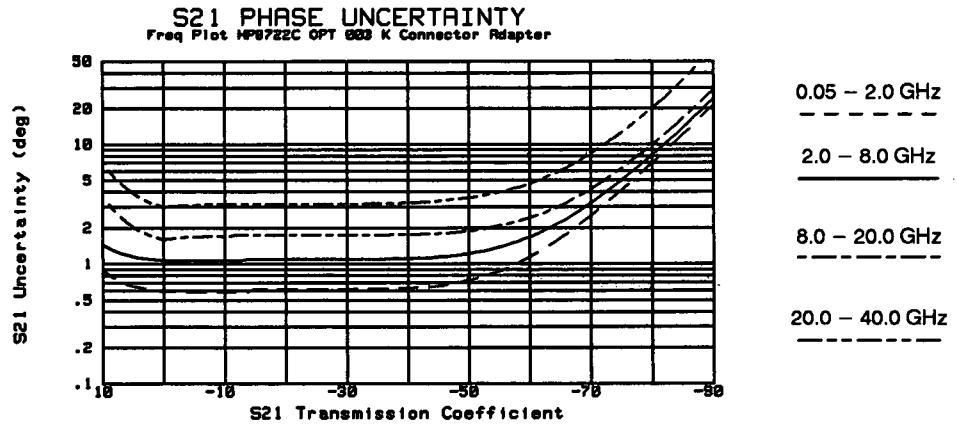
Phase

1. The graphs for transmission measurements assume a well–matched device ($S_{11} = S_{22} = 0$).

Transmission Measurements (Option 003 only) HP 8722C

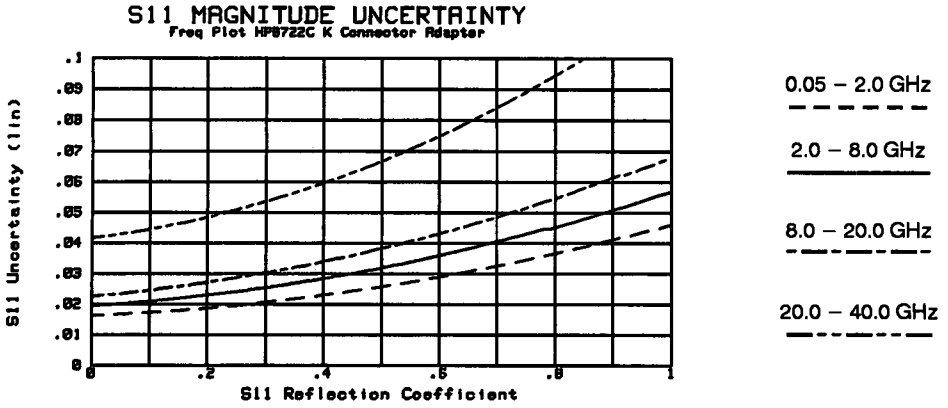


Magnitude

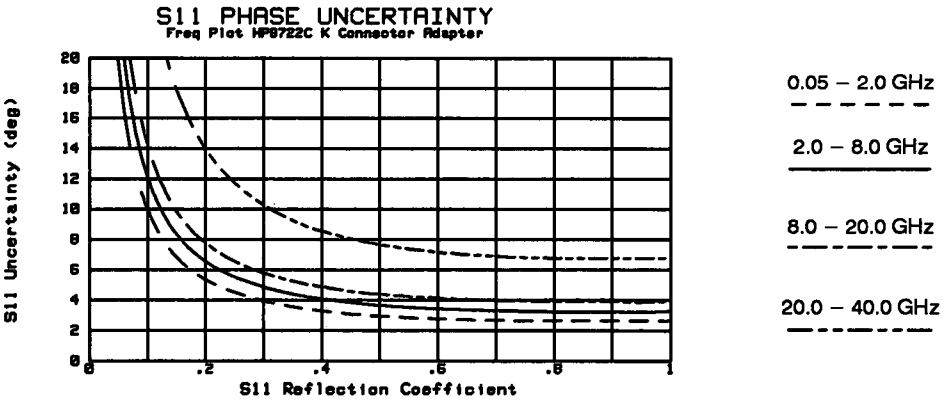


Phase

Reflection Measurements[1] HP 8722C



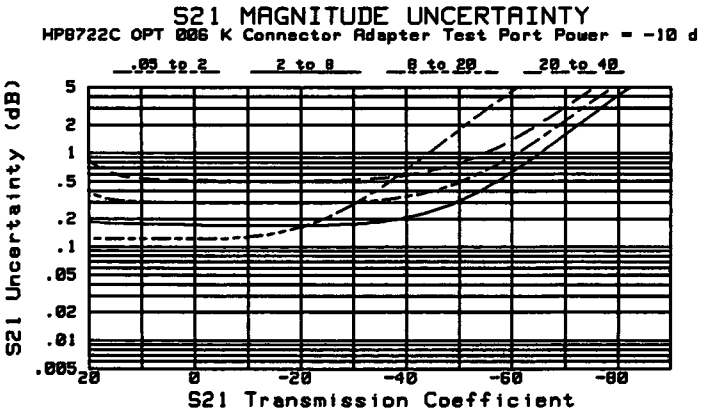
Magnitude



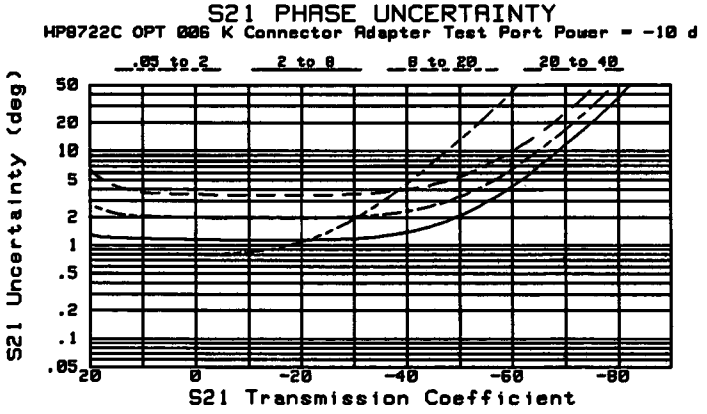
Phase

1. The graphs shown for reflection measurement uncertainty apply to a one–port device.

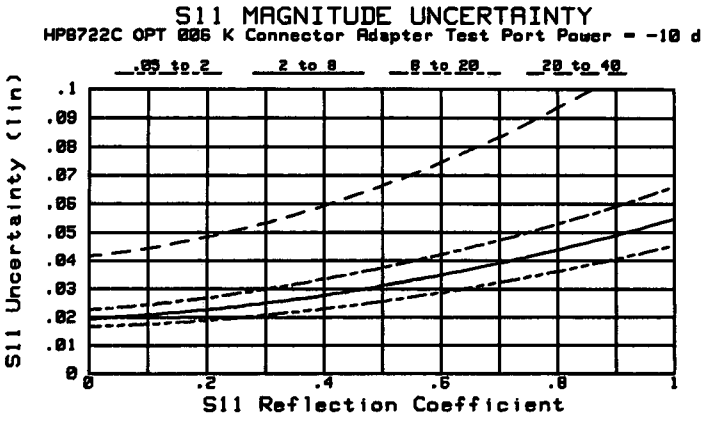
Transmission Measurements (Option 006 only) HP 8722C



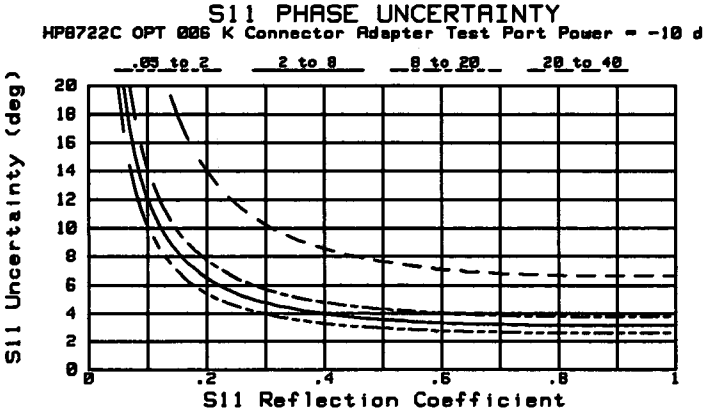
Magnitude



Phase



Magnitude



Phase

Measurement Port Supplemental Characteristics[1]

The following table shows the residual system performance (including switch repeatability) after accuracy enhancement using a full 2–port measurement calibration (including isolation) done at 2.4 mm and inserting the 2.4/2.92 mm adapter with an IF bandwidth of 10 Hz and the specified calibration kit. Environmental temperature is 23° ±3°C.

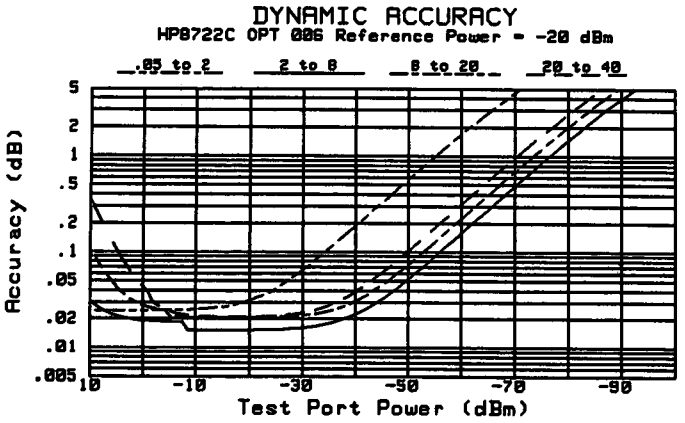
Calibration Kit: HP 85056K
(male and female broadband precision fixed loads)

Table 3–14. HP 85056K

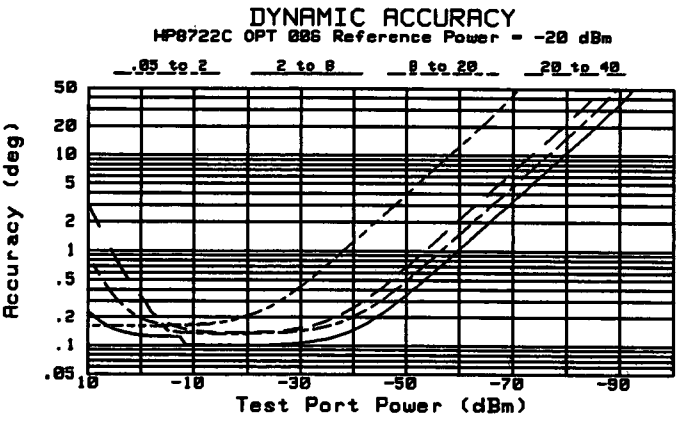
	Frequency Range			
	.050 to 2 GHz	2 to 8 GHz	8 to 20 GHz	20 to 40 GHz
Directivity	36 dB	34 dB	33 dB	28 dB
Source Match	34 dB	31 dB	30 dB	25 dB
Load Match	36 dB	34 dB	32 dB	27 dB
Reflection Tracking	.053 dB	.082 dB	.120 dB	.175 dB
Transmission Tracking	.028 dB	.068 dB	.114 dB	.264 dB

1. Crosstalk, after an isolation calibration, is no higher than the system noise floor and can be ignored.

Dynamic Accuracy



Magnitude



Phase

VERIFICATION

Chapter 4. Verification

OVERVIEW

This chapter describes the following topics:

- System performance
- System Performance verification
- Operational check procedures
- Performance tests
- Total system uncertainty test procedure
- Measurement uncertainties
- Measurement traceability
- Substitution of system components
- Calibration cycle

SYSTEM PERFORMANCE

The performance of a network analyzer system is attributable to the accuracy and stability of the entire system. The accuracy of the system is dependent on the measurement error correction. The error correction, also known as measurement calibration, is dominated by the quality of the calibration kit devices and the device models. The stability of the measurement calibration is dependent on the raw performance of each system component.

Individual System Components

The following characteristics and conditions of the system components affect the performance of the combined system configuration.

- Operating characteristics (source frequency accuracy, test port cable stability, and connector type).
- User–selected operating conditions (analyzer measurement parameter (S11, S21, S12, S22), averaging, IF bandwidth, source sweep mode, sweep speed, and power).
- Condition and quality of the components.

Calibration Kit

The quality of the measurement calibration is dominated by the accuracy of the calibration kit device models and how closely the actual electrical performance of the device meets the model. Measurement calibration errors occur when the expected, or modeled, electrical performance of the calibration standard deviates from the actual electrical performance of the standard. The calibration kit should be periodically recertified to ensure the actual electrical performance matches the model. Refer to the calibration kit manual for information on how to recertify your kit.

Measurement Process

The measurement process includes the measurement of calibration and test devices. This process encompasses connector care, the amount of flex on test port cables, the method of measurement calibration, the way you make connections (for both the measurement calibration and the DUT measurement), and connection repeatability. Connection quality is typically a small component of total system measurement error when connections are correctly made. However, poor connection quality can induce errors that significantly affect the accuracy of the measurement.

Measurement Uncertainties assure correct operation of the analyzer system. These are the recommended process checks:

- Recertify your calibration kit at the interval stated in your calibration kit manual (or more often, depending on the amount of use.).
- Review the "Microwave Connector Care Manual" to ensure that you are using correct connection techniques.
- Record the system raw error terms and compare them to periodically generated lists of the same raw error terms. By tracking the error terms, you can monitor when the system is beginning to drift, and use the data to help troubleshoot the system. Refer to Chapter 14. *"Error Terms"* in this manual for information on how to generate a list of error terms.
- Periodically measure a device (daily, for example) and compare the current results to the results previously measured. When the data begins to deviate greatly, refer to the *"Troubleshooting"* chapter in this manual.

Measurement Errors

Measurement errors prevent measured data from being a true representation of the unknown test device. In all applications, measurement errors can influence the application goals.

Network analysis measurement errors can be separated into three types: systematic errors (those which are stable and repeatable), random errors (those which are random in nature and cannot be characterized and removed), and drift errors (those associated with temperature, humidity, pressure, or other factors related to time). Measurement errors that remain after measurement calibration are called residual measurement errors. See Chapter 6, *"Measurement Calibration"* in the operating manual for a detailed description of the systematic errors corrected by measurement calibration.

Systematic Errors. These errors result from imperfections in the calibration standards, connector standards and interface, interconnecting cables, and instrumentation. Measurement calibration can reduce systematic errors.

Random Errors. These non–repeatable errors are due to trace noise, noise floor, cable stability, and connector repeatability. They affect both transmission and reflection measurements. Measurement calibration does not correct random errors.

Drift Errors. These errors result from frequency drift and instrumentation drift. They affect both transmission and reflection measurements. Instrumentation drift is primarily temperature related.

SYSTEM PERFORMANCE VERIFICATION

Performance verification is a process that verifies that the overall system is making measurements within the expected total measurement uncertainties. The entire system (hardware, calibration kit, and connections) is verified using the following procedures:

- **Operational check procedures** assess the analyzer's operating environment and the functional operation of the accessories to help identify faulty equipment. These procedures include manual check procedures as well as a firmware driven "OP CHECK." The OP CHECK tests most circuits in the analyzer. If the OP CHECK passes successfully, it verifies (with approximately 80% confidence) that the analyzer is functioning properly. These checks are recommended only and are not required. The manual operational check procedures test specific instrument features. *In Case of Difficulty* information is included here.
- **Performance Tests** verifies the source specifications of the analyzer alone. The specifications are listed in the *Specifications* section of the *Operating Manual* and on the performance test record.
- **Total System Uncertainty Test** uses a verification kit to verify the system–level error–corrected measurement uncertainty specification for the analyzer system.
- **Sources of Measurement Errors** describes random and systematic network analysis errors.
- **Measurement Uncertainty Equations** presents the equations based on the system error model in NO TAG.

- **Dynamic Accuracy.** Figure 4–12 is a typical dynamic accuracy plot for the HP 8722 that can be used to predict system performance.
- **Determining Expected System Performance** provides a system error model flowchart and a worksheet that will allow the user to determine the system performance for a specific measurement.

OPERATIONAL CHECK PROCEDURES

EQUIPMENT

Calibration Kit	HP 85056B/D
RF Cable Set	HP 85133C/D
Verification Kit	HP 85057B

The following operational checks are highly recommended, but not required. The assessment of the system operating environment and the functional operation of the system components help identify faulty equipment.

CAUTION

Use an antistatic work surface and wrist strap to lessen the chance of electrostatic discharge.

ENVIRONMENT AND DEVICE TEMPERATURE CHECK

1. Measure the temperature and humidity of the environment and write the values on the test record, located at the end of this chapter. The performance is specified at an ambient temperature of +23°C ±3°. Therefore, the environmental **TEMPERATURE MUST** remain in the range of +20°C to +26°C. Once the measurement calibration has been done, the ambient temperature must be held to ±1°C.

2. Open the calibration and verification kits and place all the devices on top of the foam so they will reach room temperature. **TEMPERATURE OF THE DEVICES IS IMPORTANT** because device dimensions (electrical characteristics) change with temperature.

3. Switch on the power to the instrument. To achieve the maximum system stability, allow the instrument to warm up for at least 1 hour before measurement calibration.

INSPECT, CLEAN, AND GAGE CONNECTORS

CAUTION

SMA connectors can easily damage the verification devices. Always use adapters when verifying a system with SMA connectors.

1. Visually inspect all the connectors for any burrs, gold flakes, or places where the gold is worn.

2. Clean all the connectors with alcohol and foam–tipped swabs. Dry the connectors with dry foam–tipped swabs.

3. Visually inspect the calibration block and the end of the connector gage before any measurements of the connectors are made.

4. Gage all devices, cables, and test port connectors.

NOTE: The procedures for correct use of gages are in the calibration kit manuals.

CABLE CHECK

The following series of cable tests (return loss, insertion loss, magnitude stability, phase stability, and connector repeatability) can be done to check the stability of a test port cable. This check is recommended to avoid spending a considerable amount of time on the verification only to have a failure caused by the cables.

Return Loss of Cables

1. Press [MENU] SWEEP TYPE MENU STEP SWP ON .

2. Perform an S11 1–port measurement calibration at test port 1. Use a lowband load and a sliding load for the loads portion of the calibration. (If your calibration kit is an economy grade, use the broadband load only.) If necessary, refer to the operating manual for a detailed measurement calibration procedure.

NOTE: If the fixed load in your calibration kit is labeled BROADBAND, you can use this load in the lowband portion of the measurement calibration.

3. Connect the test port cable to PORT 1 and tighten to the specified torque for the connector type.

4. Connect a broadband termination to the end of the cable.

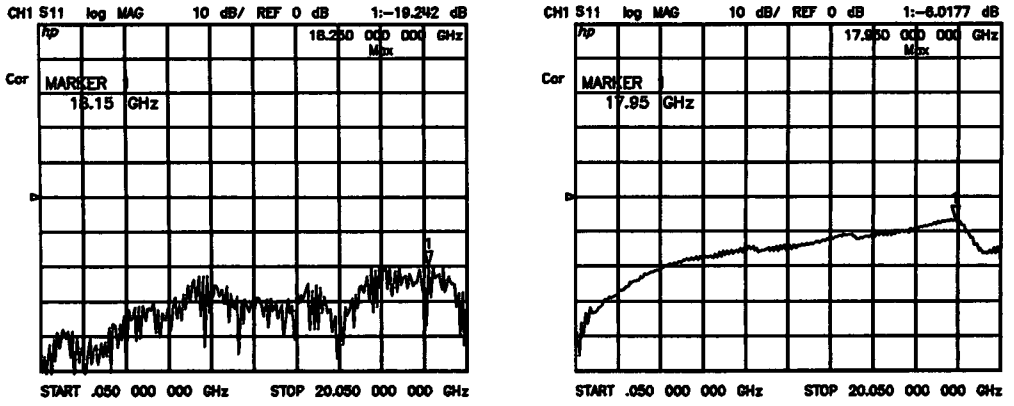
5. To measure S11 of the cable and load combination, press:

   [MEAS] Refl: FWD S11

6. To measure the return loss over the entire specified band, press [MKR FCTN] TRACKING ON MAX to find the worst case S11 measurement.

NOTE: The termination used at the cable end must be significantly higher in performance than the cable under test. It may also be gated out when using an instrument with time domain.

See Figure 4−1 for an example of a return loss measurement. Refer to the cable manual to see if the cable meets the return loss specification.



Good Cable *Bad Cable*

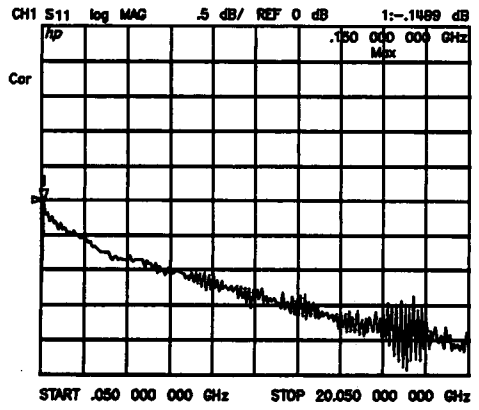
Figure 4−1. Return Loss Measurement of Cables

Insertion Loss of Cables

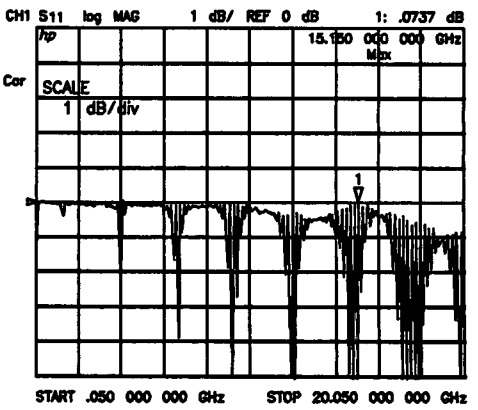
1. Replace the load with a short.

2. To measure the insertion loss of the cable over the entire specified band, press TRACKING OFF [MKR], turn the front panel knob, and look for the worst case measurement.Power holes >0.5 dB indicate a bad cable. See Figure 4−2 for example insertion loss measurements of a good and a bad cable. Refer to the cable manual to see if the cable you are measuring meets its insertion loss specification. In this S11 measurement, the displayed trace results from energy being propagated down the cable and reflected back from the short. Therefore, the correct insertion loss is approximately the measured value divided by 2 (one−way path loss of the cable).

NOTE: It is normal for the data trace to have a roll−off toward the high end of the frequency range.



Good Cable



Bad Cable

Figure 4–2. Insertion Loss Measurements of Cables

Magnitude and Phase Stability of Cables

1. To measure magnitude and phase stability, press the following keys on the analyzer:

   [DISPLAY] DUAL CHANNEL ON
   [CH 1] [FORMAT] LOG MAG
   [AVG] AVERAGING FACTOR [6] [4] [x1] AVERAGING ON
   [CH 2] [MEAS] Refl: FWD S11 [FORMAT] PHASE
   [AVG] AVERAGING FACTOR [6] [4] [x1] AVERAGING ON

2. Connect a short at the end of the cable.

3. Hold the cable in a straight line, and press the following keys to normalize the displayed traces:

   [CH 1] [DISPLAY] DATA → MEM DATA / MEM
   [CH 2] [DISPLAY] DATA → MEM DATA / MEM

4. Make a gradual 90° bend in the middle of the cable.

NOTE: The specification in the cable manual is determined from a transmission measurement (not a reflection measurement) and using a particular radius of a bend.

5. To change the scale of the displayed traces, press:

   [CH 1] SCALE REF STEP [↓] (repeat arrow key)
   [CH 2] SCALE REF STEP [↓] (repeat arrow key)

6. To mark the end of the cable's specified range, place a marker on the highest specified frequency of the cable. Press:

   [MKR] (enter the specified frequency) [G/n]

7. Place a marker on the largest deflection that goes above and below the reference line and is within the specified frequency range. See Figure 4–3 for example plots of this measurement. Press:

   MARKER 2 (turn the front panel knob)

   In this S11 measurement, the displayed trace results from energy being propagated down the cable and reflected back from the short. Therefore, the measured deflection value must be divided in half to reach the correct value. Refer to the cable manual to see if the cable meets the magnitude and phase stability specifications.

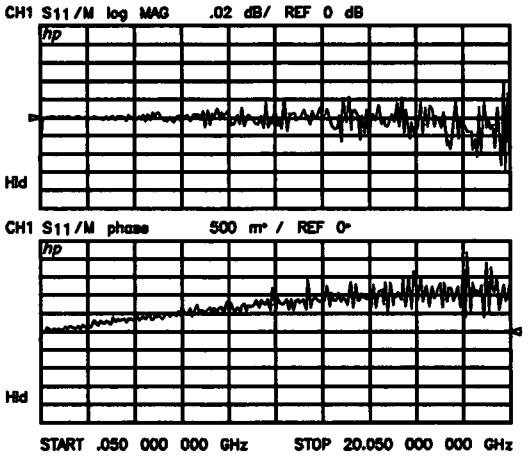


Figure 4–3. Cable Magnitude and Phase Stability

Cable Connector Repeatability

1. To measure the cable connector repeatability, connect a broadband termination at the end of the cable.

2. Press the following keys on the analyzer:

   [CH 1] [DISPLAY] DUAL CHANNEL OFF DISPLAY: DATA

   [AVG] AVERAGING FACTOR [1] [2] [8] [x1] AVERAGING ON

3. To normalize the data trace press:

   [DISPLAY] DATA → MEM DATA - MEM

   [SCALE REF] REFERENCE VALUE [–] [5] [0] [x1]

   [SCALE REF] SCALE/DIV [2] [0] [x1]

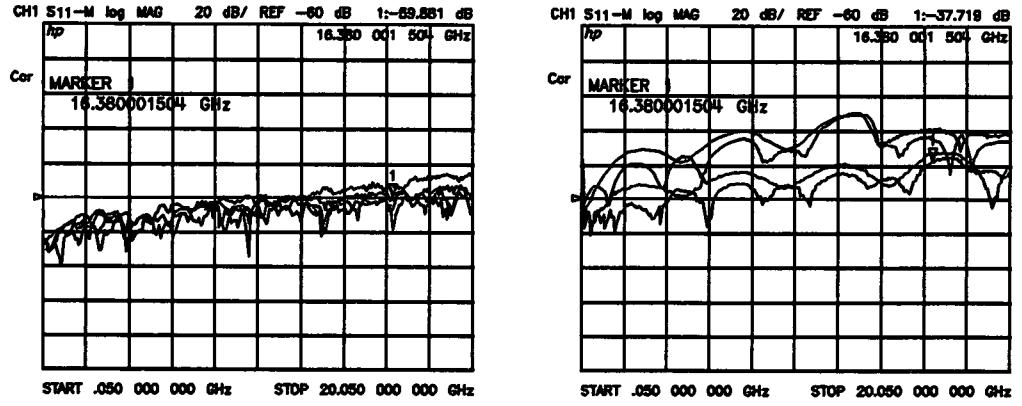
4. Disconnect and then reconnect the cable to the test port. Tighten the connection to the specified torque for the connector type. Look at trace for spikes or modes.

5. To re−normalize the data trace of the reconnected cable press:

   DISPLAY DATA → MEM

6. Repeat steps 4 and 5 at least 3 times to look for modes. Modes appear when a harmonic of the source fundamental frequency is able to propagate through the cable or connector. Any mode that appears each time the cable is connected and reconnected will affect measurement integrity. It is helpful to be able to plot the trace each time to compare several connections. Refer to the example plot in Figure 4−4.

NOTE: The connector repeatability measurement should be done at the test port as well as at the end of the test port cable.



Good Cable ***Bad Cable***

Figure 4−4. Connector Repeatability Examples

POWER LEVEL CHECK

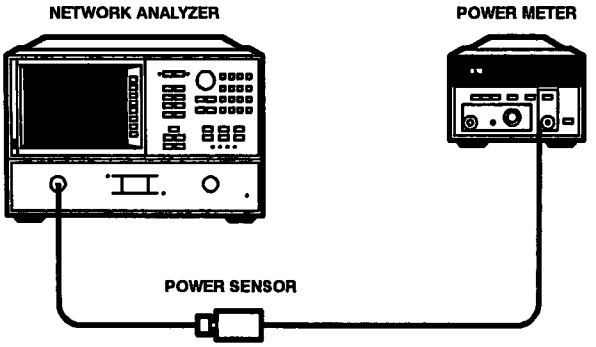


Figure 4–5. Power Level Test Setup

EQUIPMENT

Power meter	HP 436A, HP 437A/B, or 438A
Power sensor	HP 8487A
2.4 mm (f)/2.4 mm (f) adapter	11900B (part of 85056B/D)

DESCRIPTION AND PROCEDURE

The source power level is tested at 201 frequencies across the frequency range of the analyzer. Warm–up time: 30 minutes.

1. Zero and calibrate the power meter. Set the cal factor on the power meter to the average value of the power sensor between 0.050 and 40 GHz. (For example, if the power sensor cal factor is 100% at 0.050 GHz and 92% at 40 GHz, set the cal factor to 96%.)

2. Connect the power sensor to port 1 of the analyzer as shown in Figure 4–5.

3. On the analyzer, press [RECALL] RECALL FAC PRESET. Press SWEEP TIME [MANUAL] [3] [0] [0] [x1] to begin the 300 second sweep.

   The 8722 "C" power level check must be done in two bands:

   (a) Press [STOP] [2] [6] [.] [5] [G/n] [MENU] POWER RANGE 1 (–20 to 0 dBm) [0] [x1].

   (b) Press [STOP] [2] [6] [.] [6] [G/n] [STOP] [4] [0] [G/n] [MENU] POWER RANGE 2 (–20 to –5 dBm) [–] [5] [x1].

4. During the sweep, note the maximum and minimum power level readings in Table 4–1 on page 4–12. The instrument remains at each frequency point for 1.5 seconds to allow the power meter sufficient time to settle.

Table 4–1. Power Level Check

Test Description	Minimum	Results	Maximum	Measurement Uncertainty
Power Level				
Freq. range (GHz)				
8722A Full Band	−18 dBm	_____	−12	.3 dB
Freq. range (GHz)				
8722C				
0.05–2.0	−3.5 dBm	_____	+3.5	.3 dB
2.0–8.0	−3.5 dBm	_____	+3.5	.3 dB
8.0–26.5	−3.5 dBm	_____	+3.5	.3 dB
26.5–40*	−8.5 dBm	_____	−1.5	.3 dB

* On option 003 instruments applicable to port 1 only.

IF THE INSTRUMENT FAILS THIS TEST

Ensure that the power meter and power sensor are operating to specification. Inspect the analyzer port 1 connector, the adapter and the power sensor connector for damage. Poor match at these connections can generate power reflections and cause the analyzer to appear to be out of limits. Repeat the measurement at port 2 (press [MEAS] **Refl: REV S22** to drive port 2).

Marginal failures (especially at the high or low end) may be due to the power sensor cal factor approximation method of step 1. A cal factor approximation of ±4%, as in the above example, induces an error of about 0.15 dB. To eliminate the cal factor approximation as the cause of failure, press [MENU] **CW FREQ** and rotate the knob to the frequency in question. Set the cal factor on the power meter to the value indicated by the power sensor. The corrected power level reading should be between −12 dBm and −18 dBm.

The source relies on the *Power Adjustments* for proper performance. Refer to *Adjustments* for additional information.

In case of catastrophic failure, refer to *Source Troubleshooting*.

DYNAMIC RANGE CHECK

EQUIPMENT

Calibration kit	HP 85056B/D
RF cable set	HP 85133C/D

*other cal kits may be used if working in a different connector type

DESCRIPTION AND PROCEDURE

Dynamic range is checked by comparing the noise floor to the test port output power level (determined in the power level performance test). See Table 4–2 for typical dynamic range performance.

1. Press [RECALL] RECALL FAC PRESET [AVG] IF BW [1] [0] [x1] [MENU] NUMBER of POINTS [8] [0] [1] [x1] [SCALE REF] [2] [x1] [MEAS] Trans: FWD S21 to set up the first measurement.

2. Connect a thru (RF cable) between ports 1 and 2. Press [CAL] CALIBRATE MENU RESPONSE & ISOL'N RESPONSE THRU. At the beep, press DONE:RESPONSE and remove the thru.

   Connect 50 ohm terminations to ports 1 and 2. Press [AVG] AVERAGING ON [CAL] RESUME CAL SEQUENCE ISOL'N STD. At the beep, when one of the terminations has been measured over 16 sweeps, press DONE RESP ISOL'N CAL.

3. Press [AVG] SMOOTHING ON SMOOTHING APERTURE [.] [2] [x1]. When the measurement has been averaged sixteen times, press [MKR] and use the knob to determine the maximum points in the frequency bands listed in the *Performance Test Record*. Record the S21 maximum points there.

NOTE: To emphasize the frequency bands, press [MKR] [2] [G/n] MARKER 2 [8] [G/n] MARKER 3 [2] [0] [G/n] MARKER 4. Then move marker 4 with the knob to find the maximum points in the four frequency bands.

4. Press [MEAS] Trans: REV S12 [AVG] AVERAGING OFF SMOOTHING OFF to set up the second measurement. Repeat steps 2 and 3. Record the S12 maximum points in Table 4–2 on page 4–14.

Table 4–2. Dynamic Range Check[1]

Test Description	Minimum		Results Port 1	Results Port 2	Measurement Uncertainty
Dynamic Range					
Freq. range (GHz)	8722A	8722C			
0.05 – 2.0	61 dB	76 dB	_____	_____	3 dB
2.0 – 8.0	78 dB	98 dB	_____	_____	3 dB
8.0 – 20	76 dB	93 dB*	_____	_____	3 dB
20 – 40	71 dB	87 dB	_____	_____	3 dB

Table 4–2a. Dynamic Range Check (Option 003)[1]

Test Description	Minimum		Results	Measurement Uncertainty
Dynamic Range				
Freq. range (GHz)	8722A	8722C		
Forward S21				
0.05 – 2.0	95 dB	107 dB	_____	3 dB
2.0 – 8.0	93 dB	107 dB	_____	3 dB
8.0 – 20	90 dB	102 dB*	_____	3 dB
20 – 40	76 dB	107 dB	_____	3 dB
Dynamic Range				
Freq. range (GHz)	8722A	8722C		
Reverse S12				
0.05 – 2.0	25 dB	82 dB	_____	3 dB
2.0 – 8.0	68 dB	82 dB	_____	3 dB
8.0 – 20	68 dB	80 dB*	_____	3 dB
20 – 40	59 dB	79 dB	_____	3 dB

[1] With HP 85133C flexible cable on test port.

* Valid to 26.5 GHz

IF THE INSTRUMENT FAILS THIS TEST

First suspect the connections, the calibration standards and the cable. Visually inspect all of the connectors and repeat the test. In case of repeat failure, gage the connectors (see the *Microwave Connector Care Manual*), substitute calibration standards and cable. Perform the sampler check (see *Adjustments and Correction Constants*). Check the output power of the source.

Refer to the *Isolate Faulty Group* section for additional help.

OPERATOR'S CHECK

DESCRIPTION

The operator's check consists of two softkey initiated tests: "OP CK PORT 1" and "OP CK PORT 2".

A short is connected to port 1 (port 2) to reflect all the source energy back into the analyzer for an S11 (S22) measurement.

The first part of "OP CK PORT 1" checks the repeatability of the transfer switch. An S11 measurement is stored in memory and the switch is toggled to port 2 and then back to port 1 where another S11 measurement is made. The difference between the memory trace and the second trace is switch repeatabilty.

The remaining parts of both tests also exercise the source across its full frequency range at −15 dBm and then the internal attenuator is adjusted in 5 dB steps over a 40 dB range. The receiver inputs are tested across their full frequency range at several power levels in ratio modes.

The resulting measurements must fall within a limit testing window to pass the test. The window size is based on both source and receiver specifications.

The operator's check determines that:

1. The source is phase−locked across the entire frequency range.
2. All three samplers are functioning properly.
3. The transfer switch is operational.
4. The attenuator steps 5 dB at a time.

EQUIPMENT

Short 2.4 mm (f) ..... (p/o calibration kit HP 85056B/D)

PROCEDURE

1. Allow the analyzer to warm up for 30 minutes.
2. First, run the test for port 1: press [RECALL] RECALL FAC PRESET, then [SYSTEM] SERVICE MENU TESTS EXTERNAL TESTS.
3. The display should show "TEST 21 Op Ck Port 1" in the active entry area.

4. Press EXECUTE TEST to begin the test.

5. At the prompt, connect the short to the port indicated. Make sure the connection is tight.

6. Press CONTINUE.

7. The test is a sequence of subtests. At the end of the subtests, the test title and result will be displayed. If all tests pass successfully, the overall test status will be "PASS". If any test fails, the overall test status will be "FAIL".

8. Next, run the test for port 2: press the step [↑] key. The display should show "TEST 22 Op Ck Port 2" in the active entry area.

9. Repeat steps 4 through 7.

10. If both tests pass, the analyzer is about 80% verified. If either test fails refer to *In Case of Difficulty* information in this section, or:

    a. Make sure that the connection is tight. Repeat the test.

    b. Visually inspect the connector interfaces and clean if necessary (refer to the *Microwave Connector Care Manual* supplied in the *Operating Manual*).

    c. Verify that the short meets published specifications.

    d. Substitute another short, and repeat the test.

    e. Finally, suspect a problem with the analyzer. Refer to the detailed tests located in this section, or fault isolation procedures located in the *Troubleshooting* sections.

IN CASE OF DIFFICULTY

This section describes common problems or apparent failures, as well as easy solutions that can be performed with the instrument covers on. An operator can solve many problems easily and quickly, with minimal network analyzer experience and some simple tools.

If the listed solution does not seem to fix the problem, go to the *Troubleshooting* section in this *Service Manual*, or contact your local HP service representative.

The problems are listed below by symptom, together with solutions.

Symptom: **Instrument appears dead and the instrument fan is off.**
Solution: Check that the main power supply line is providing power. Check the two LEDs on the rear panel: the green LED should be ON and the red LED should be OFF. Check that the line voltage selector switch position matches the line power voltage (120 Vac or 240 Vac). Check the fuse (refer to *Installation* in the User's Guide).

Symptom: **Display screen is blank or out of focus, but CH 1 or CH 2 LED is lit.**
Solution: Adjust the display intensity or focus with the front panel keys. Refer to *[DISPLAY]* Key in Chapter 5 of the *Operating Manual*, and *Display Intensity and Focus Correction Constants* in the *Adjustments* section of this manual.

Symptom: **Self test fail message is displayed on the CRT immediately after power-on or preset.**
Solution: Contact a qualified service technician.

Symptom: **Phase lock error message is displayed (this includes the "PHASE LOCK CAL FAILED" message).**
Solution: Contact a qualified service technician.

Symptom: **Internal transfer switch will not switch and the lower front panel LEDs are not lit.**
Solution: Contact a qualified service technician.

Symptom: **Measurements are not repeatable, especially after measurement calibration.**
Solution: Check all RF cables and connections. Visually inspect all connectors, and clean if necessary (refer to the *Microwave Connector Care Manual*, supplied in the *Operating Manual*). Review proper connection techniques to ensure good, repeatable connections.

Symptom: **Instrument cannot be programmed via HP-IB.**

Solution: Check the HP-IB cabling connections. Check that the HP-IB addresses match the addresses being programmed (refer to Chapter 8 of the *Operating Manual*). Check that the analyzer is set to either TALKER/LISTENER or USE PASS CONTROL under the [LOCAL] key. Check that the controller can program an instrument that is known to be working.

Symptom: **Instrument states cannot be saved or recalled from external disk.**
Solution: Check the HP-IB cabling connections. Check the address of the disk drive. Make sure the analyzer is set to SYSTEM CONTROLLER under the [LOCAL] key. Check that the disk drive works normally with a controller. Initialize the disc.

Symptom: **Printer/plotter does not respond to front panel commands.**
Solution: Check the address of the printer or plotter. Make sure the analyzer is set to SYSTEM CONTROLLER under the [LOCAL] key.

Symptom: **"CAUTION: Air Flow Restricted. Check Fan Filter" message is displayed on CRT.**
Solution: Check if anything is blocking the fan. Clean the fan filter (refer to the *Routine Maintenance* information in this manual).

PERFORMANCE TESTS

INTRODUCTION

This section consists of step–by–step performance tests that verify certain performance specifications of the network analyzer. They may be performed singly, or in any order desired. Approximately one hour is required to complete the performance tests, not including instrument warm–up time of 30 minutes.

The performance tests and page numbers are:

Frequency range and accuracy	page 4–19
Total System Uncertainty Test	page 4–20
(Performance test record)	page 4–54

PERFORMANCE TEST TOOLS

Run the analyzer internal tests before performing the performance tests (press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS INTERNAL TESTS EXECUTE TEST). These quick, automated internal checks may save time by indicating an instrument fault before time is invested doing performance tests. Internal tests are described in the *Service Key Menus* section of this manual.

The *Microwave Connector Care Manual* (HP part number 08510–90064) contains specific information on the use, cleaning, mating, and gaging of connectors. Make sure that the test equipment used in each test meets its own published specifications and that all connectors are clean.

The table of Service Test Equipment in the *Service and Equipment Overview* section lists the necessary equipment (and critical specifications) to perform the performance tests. Equipment lists for individual tests are provided in each performance test.

The *Performance Test Record* at the end of this section provides a list of the specifications and acceptable limits for the performance tests, as well as a column to record actual measurements.

The table of Related Service Procedures in the *Post–Repair Procedures* section shows which performance tests and adjustments are interactive. Refer to it following adjustment or repair of the instrument.

CALIBRATION CYCLE (PERFORMANCE VERIFICATION)

The performance of the network analyzer should be verified at least once per year. Verification consists of performing the Total System Uncertainty Test and the performance tests.

IF THE INSTRUMENT FAILS A TEST

Refer to "If The Instrument Fails This Test" (at the end of each performance test) for troubleshooting hints and references to other manual sections to help resolve any problems.

FREQUENCY RANGE AND ACCURACY PERFORMANCE TEST

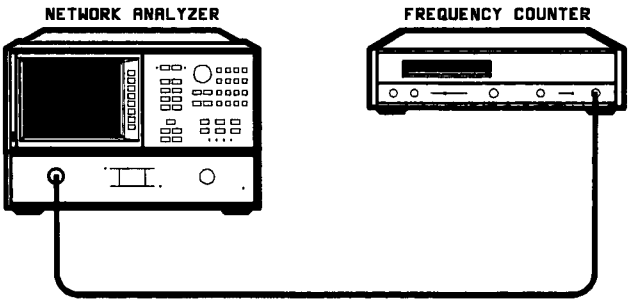


Figure 4–6. Frequency Range and Accuracy Test Setup

EQUIPMENT

Frequency counter	HP 5351B
RF cable	HP 85133C/D

DESCRIPTION AND PROCEDURE

This test checks the frequency accuracy of the analyzer over its entire frequency range. See the *Performance Test Record* (at the end of this section) for specifications. Warm–up time: 30 minutes.

1. Connect the equipment as shown in Figure 4–6 and press [RECALL] RECALL FAC PRESET [MENU] CW FREQ.

2. Press [2] [5] [.] [5] [0] [G/n] to select a CW frequency of 25.5 GHz. Record the frequency counter reading on the *Performance Test Record*.

IF THE INSTRUMENT FAILS THIS TEST

If any frequency measured is close to specification limits (either in or out of specification), check the time base accuracy of the counter used.

If the analyzer fails by a significant margin at all frequencies (especially if the deviation increases with frequency), the master time base probably needs adjustment. In this case, refer to the frequency accuracy adjustment in *Adjustments*. See *Source* for related troubleshooting information.

TOTAL SYSTEM UNCERTAINTY TEST PROCEDURE

DESCRIPTION

The procedure consists of calibrating the analyzer with a calibration kit, measuring a set of characterized devices, and comparing the resultant measured data to the data and uncertainty limits supplied with the verification kit. The device data provided with the verification kit has a traceable path to NIST. The total measurement uncertainty limits for the performance verification are the sum of the factory measurement uncertainties for the verification devices and the uncertainties associated with the system being verified. The difference between the supplied traceable data and the measured data must fall within the total uncertainty limits at all frequencies for the system uncertainty test to pass. You can compare the factory system measurement uncertainty to your system measurement uncertainty in "Comparing system Measurement Uncertainties for the Performance Verification Devices" located later in this chapter.

When an HP 8722 system passes this test it does not ensure the system meets all the performance specifications. However, it does show the system being verified measures the same devices with the same results as a factory system which has had all its specifications verified and its total measurement uncertainty has been minimized to the smallest extent possible.

VERIFICATION KIT

A verification kit is used in the following procedure. The kit consists of two attenuators, a 25Ω mismatch airline, a 50Ω airline, a data disk containing the factory measured verification data, uncertainty limits of an HP 8722 system, printout of the factory uncertainties for the devices in the kit, and a Certificate of Calibration.

SYSTEM VERIFICATION CYCLE AND KIT RE–CERTIFICATION

The recommended system verification cycle is one year. It is also recommended that the verification kit and calibration kit be re–certified annually. For more information about kit re–certification, refer to the manual of the verification kit being used.

MEASUREMENT UNCERTAINTY

The measurement uncertainty is defined to be the sum of the residual systematic (repeatable) and random (non–repeatable) errors in the measurement system after accuracy enhancement. The systematic errors are directivity, source match, load match, reflection and transmission frequency tracking, and isolation (crosstalk). Random errors include errors due to noise, drift, connector repeatability, and test cable stability. A complete description of system errors and how they affect measurements is provided under *Accuracy Enhancement Fundamentals* in Chapter 6, *Measurement Calibration* of the *Operating Manual*.

Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends on its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst case (−180 to +180 degrees). Random errors such as noise and connector repeatability are generally combined in a root−sum−of−the−squares (RSS) manner.

MEASUREMENT TRACEABILITY

To establish a measurement traceability path to a national standard for a network analyzer system, the overall system performance is verified through the measurement of device characteristics that have a traceability path. This is accomplished by electrically measuring devices in an HP verification kit. Refer to "How to Verify System Performance" for the system performance verification procedure.

The measurement of the verification kit device characteristics has a traceable path because the factory system that characterizes the devices is calibrated and verified by measuring standards that have a traceable path to the National Institute of Standards Technology (NIST). This chain of measurements defines how the verification process brings NIST traceability to the HP 8722 system measurements. Therefore, when your analyzer system is verified through the performance of the "Total System Uncertainty" procedure, a measurement traceability path is established.

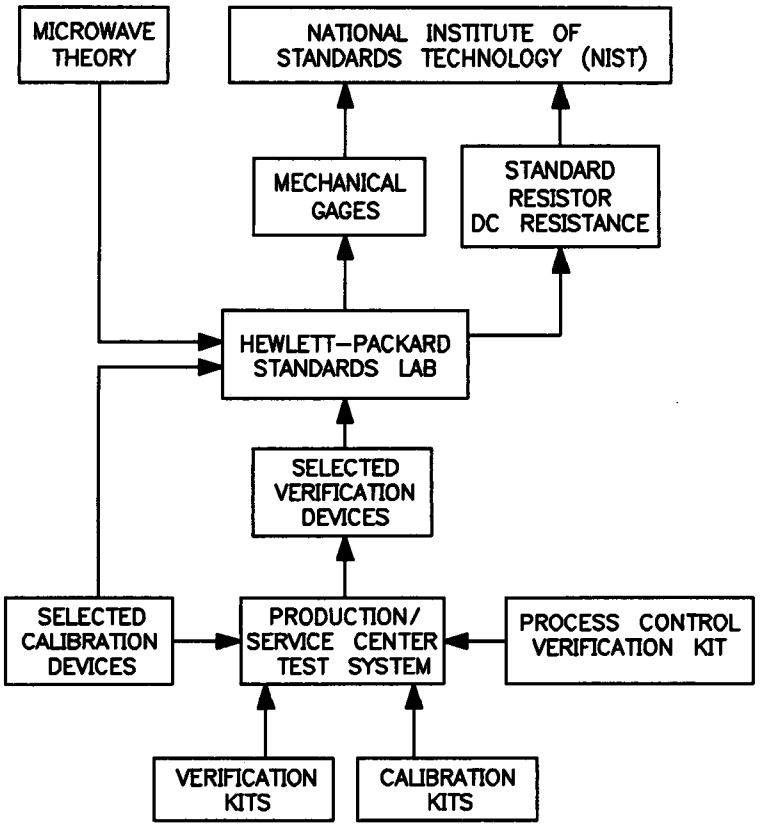


Figure 4-7. National Institute of Standards Technology Traceability Path for HP 8722 System Calibration and Verification Standards

EQUIPMENT

The system verification procedure verifies the minimum HP 8722 system, which includes the following:

- the network analyzer
- calibration kit
- test port return cables

NOTE: Additional equipment or accessories used with the above system are not verified by system verification.

The following equipment and accessories are required to verify the network analyzer system (for information on compatible printers, refer to the *General Information* section of the *Operating Manual*).

- HP 9122C/D/S CS80 disk drive
- HP 2225A ThinkJet printer (or other compatible printer)
- HP 10833 A/B/C/D HP-IB cables (2)
- Verification kit See Table 4-3 on page 4-23.
- Calibration Kit. See Table 4-3.
- Test port return cables. See Table 4-3.

Table 4-3. Supported System Configurations

Description	2.4 mm	3.5 mm
Calibration Kit	85056B/D	85052B/D
*Verification Kit	85057B	85053A/B
Cables	85133D/F	85131D/F

* Verification kits that do not contain HP 8722 data must be recertified. The disk in the verification kit must be labeled "Rev A.1" or later.

Cable Substitution

The test port cables specified for an HP 8722 system have been characterized for connector repeatability, magnitude and phase stability with flexing, return loss, insertion loss, and aging rate. Since the performance of test port cables is a very significant contributor to the system performance, substituting specified cables with cables of lower performance will increase the uncertainty of your measurement verification. Refer to the plots in the cable checks (earlier in this chapter) that show the difference in performance between good and bad cables. It is highly recommended to periodically check test port cables to determine if they are good.

If the system verification is performed with non-HP cables and fails but is then repeated with HP cables and passes, the non-HP cables are at fault. (It must be documented in the comments area of the performance verification printout that non-HP cables were used in the system.) The effects of the non-specified cables cannot be taken into account in the performance verification procedure.

See supported system configurations in Table 4-3.

Calibration Kit Substitution

The accuracy of the HP 8722 when used with any calibration kit is dependent on how well the kit standards are defined.

The measurement specifications for the HP 8722 system include measurement calibration with an HP calibration kit. Measurement calibrations made with user defined or modified calibration kits are not subject to the HP 8722 performance specifications, although a procedure similar to the standard verification procedure may be used.

See supported system configurations in Table 4-3.

CALIBRATION CYCLE

The recommended system calibration cycle is once every year for supported system configurations.. However, that does not extend past the test ports of the test set if non−HP cables are used (test port cables, text fixtures, adapters, etc.). The calibration cycle for the system is unknown with non−HP cables, and must be determined by the owner since the stability, repeatability, and aging rate characteristics of the test port cables are unknown. The user of the system should determine the calibration interval based on the amount of use and the degree of cable movement.

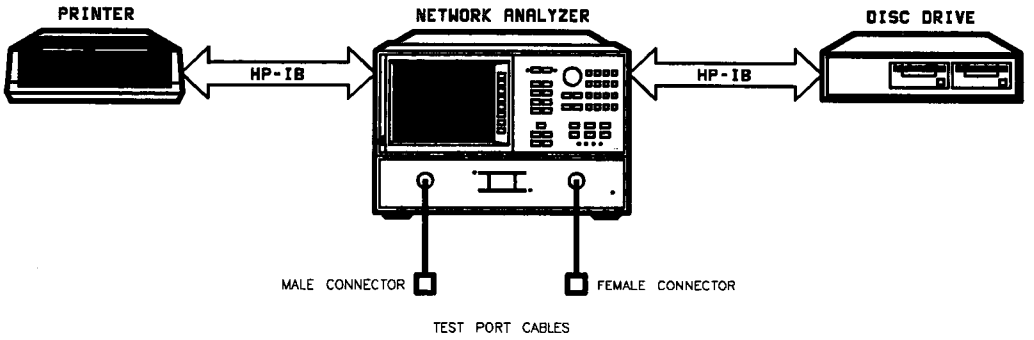


Figure 4−8. System Verification Setup

PROCEDURE

1. Connect the system as shown in Figure 4−8.
2. Insert the verification disk marked Rev B.1 (supplied in the verification kit) into drive 0 (left disk drive).
3. Allow the system to warm up for one hour.
4. Ensure printer HP−IB address is set to 5, disk drive to 0, analyzer to 16 on both the analyzer and the HP−IB device.
5. Review the *Microwave Connector Care Manual* supplied in the *Operating Manual* for proper care and connection techniques for microwave connectors. Proper connections and clean, undamaged connectors are critical for accurate measurement results.

Initialization

6. Press [RECALL] **RECALL FAC PRESET** . No other controller should be connected to the bus. Press [LOCAL] **DISK UNIT NUMBER** , and change the setting if necessary.

7. Press SET ADDRESSES and check the disk unit number, and the address of the disk drive and printer. The default unit number and address for the disk drive are both 0. The default address for the printer is 1.

8. To print a title of a maximum of 48 characters, i.e. date and customer name, on each verification result, press: DISPLAY MORE TITLE ERASE TITLE then enter the title you wish to display using the RPG. When the title is entered press DONE.

9. If a printout of data for only a particular verification device is desired, go to the next step; the record function will be turned on later in the verification procedure.

   If a printout of *all* verification data for *all* devices is required, press SYSTEM SERVICE MENU TEST OPTIONS RECORD ON. All results will be printed. If output of graphical data is required, press DUMP GRAPH ON. Dumping of graphs will increase verification time by about 30 minutes. Note that if these functions are turned on now, they cannot be turned off during the verification procedure. (Make sure the paper in the printer is set up so that printing starts at the top of the page.)

10. Press SYSTEM SERVICE MENU TESTS SYS VER TESTS. The message "TEST 26 Sys Ver Init —ND—", will be displayed. The "—ND—" indicates the test status. A listing of the test status codes that may appear during this procedure is available in Table 4–4 below. If the record function is on, "/REC" will also be displayed.

Table 4–4. Listing of Test Status Codes

PASS	
FAIL	
(NA)	NOT AVAILABLE
—ND—	NOT DONE
—IP—	IN PROGRESS
DONE	

11. Press EXECUTE TESTS. This recalls the instrument state file from the disk and sets up the analyzer for a measurement calibration. When it is done initializing, "TEST 26 Sys Ver Init DONE" will be displayed. Do not preset or power cycle the instrument. Do not attempt to recall a previous calibration. These actions will destroy the initialization achieved in steps 8 and 9.

Measurement Calibration

The following measurement calibration procedure characterizes and effectively removes the systematic errors present in the system. This involves measuring a set of calibration devices, supplied in the calibration kit, with known electrical characteristics. Following the calibration, the verification procedure will verify that the sum of the residual errors present after calibration is within the specified uncertainty limits. The measurement calibration must be performed before continuing on to the system verification. The calibration and verification kits used must be of the same connector type.

NOTE: Do not preset or power cycle the instrument. If you do, you must repeat steps 8 and 9.

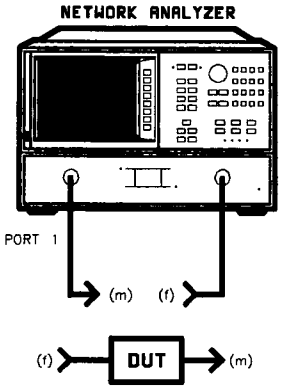


Figure 4–9. Test Port Cabling

12. Press [CAL] **CAL KIT** and select the type of cal kit to be used. Then press **RETURN** **CALIBRATE MENU** **FULL 2-PORT** **REFLECT'N**.

13. Connect the open circuit to the port 1 cable. Press **S11: OPEN**.

14. When the measurement is complete, disconnect the open. (Measurements are complete when the instrument beeps and the softkey that was pressed is underlined.)

15. Connect the short to the port 1 cable. Press **S11: SHORT**.

16. When the measurement is complete, disconnect the short.

17. Press **S11: LOADS**. Connect a load to the port 1 cable.

NOTE: For broadband measurements, use either a broadband load or a combination of lowband (or broadband) and sliding loads. Use the same loads used during normal calibrations.

18. Press either **BROADBAND** or **SLIDING**, depending on which device is used. If you select **SLIDING**, you must also measure a lowband load to complete the loads calibration.

19. When the measurement is complete, press DONE:LOADS. Leave the load connected to the port 1 cable.

20. Connect the open to the port 2 cable. Press S22: OPEN.

21. When the measurement is complete, disconnect the open. Connect the short to the port 2 cable. Press S22: SHORT.

22. When the measurement is complete, disconnect the short.

23. Press S22 LOADS. Connect a load to the port 2 cable. Press either BROADBAND or SLIDING, depending on which device is used. If you select SLIDING, you must also measure a lowband load to complete the loads calibration.

24. When the measurement is complete, press DONE: LOADS. Leave the load connected to the port 2 cable.

25. Press REFLECT'N DONE.

26. After the calibration coefficients are computed, the 2-port cal menu is returned to the screen.

27. Press ISOLATION DO BOTH FWD + REV.

28. Disconnect the loads.

29. Press TRANSMISSION.

30. Connect the two test port return cables together to form a "thru" configuration.

31. Press DO BOTH FWD + REV.

32. Press DONE 2-PORT CAL.

33. The save softkey menu will automatically be displayed. Save the calibration in any register.

34. Calibration is now complete.

System Verification

The following verification procedure is contained in the analyzer firmware. For each verification device, the analyzer reads a file from the verification disk and sequentially measures the magnitude and phase for all four S-parameters.

The device number and test number for each verification device are as follows:

Verification Device	Test Number	Device Description
1	27	20 dB attenuator
2	28	40/50 dB attenuator
3	29	50Ω airline
4	30	25Ω mismatch airline

35. Press [SYSTEM] SERVICE MENU TESTS [2] [7] [x1].

36. In the active entry area on the CRT, the following will be displayed:

    "TEST 27 Ver Dev 1"

37. If the record function was turned on in step 7, or if a printout is not desired, go to the next step.

    If a printout of the data for this device is desired, press [SYSTEM] SERVICE MENU TEST OPTIONS RECORD ON [SYSTEM] SERVICE MENU TESTS. Make sure the paper in the printer is set up so that printing starts at the top of the page.

CAUTION

See pages 4–32 to 4–34 for proper handling of airlines.

38. Press EXECUTE TESTS.

NOTE: When printing test results, press FORM FEED on the printer to create page breaks in appropriate places.

39. When prompted, insert the 20 dB attenuator.

Connecting Device

When measuring devices, connect the female end of the device to the port 1 cable.

For instructions on the proper connection of the 50Ω and 25Ω airlines, refer to *Connecting the Airlines*.

40. Press CONTINUE. The tests will begin.

41. If the record function is off (printout is not required), the program will pause after each S–parameter measurement and you will need to press CONTINUE after each measurement. (There are eight measurements for each device – magnitude and phase for each of the four S–parameters.)

NOTE: Although the verification limits for all four S–parameters are calculated, only the uncertainties associated with the items indicated in the following chart will be used for the system verification. The other characteristics are less significant for verifying system performance; therefore, they will not appear on the printout. If a measurement fails, note which device and S–parameter failed, and continue on with the remaining tests.

Also note that both the measured data and the factory data are displayed on the CRT.

Verification Device	S11/S22 Magnitude	S11/S22 Phase	S21/S12 Magnitude	S21/S12 Phase
20 dB attenuator	x		x	x
40 dB attenuator	x		x	x
Airline	x	x	x	x
Stepped impedance airline (rho = 0.6 std)	x	x	x	x

42. When all tests are complete, the TESTS softkey menu will appear. Disconnect the verification device.

43. Enter Test 28 (using step keys, entry keys, or RPG). Repeat steps 35 through 40 with the 40 or 50 dB attenuator.

44. Enter Test 29 (using step keys, entry keys, or RPG). Repeat steps 35 through 40 with the 50Ω airline. See *Connecting the Airlines,* located in this chapter.

45. Enter Test 30 (using step keys, entry keys, or RPG). Repeat steps 35 through 40 with the 25Ω mismatch airline. See *Connecting the Airlines,* located in this chapter.

46. The printout of the measurements shows both a plot of the measurement and a list of the measured frequencies with corresponding data. The plot includes both the measured data trace and the supplied factory data trace. The listing includes only the measured data. If there is a failure at any frequency, an asterisk will be next to the measured data and the out–of–specification measured data on the plot will be blanked out.

IN CASE OF FAILURE

1. If correction has been turned off and the message CAUTION: CALIBRATION REQUIRED is displayed, repeat the entire procedure. This time, heed the cautions in step 9.

2. Ensure that the system is properly cabled. Refer to Figure 4–9. Improper cabling may cause failure (especially with the 25Ω airline).

3. Verify that the disk in the verification kit matches the devices in the kit. Check the serial number of the device against the serial number encoded in the title area of the display when the instrument state files for that device are recalled.

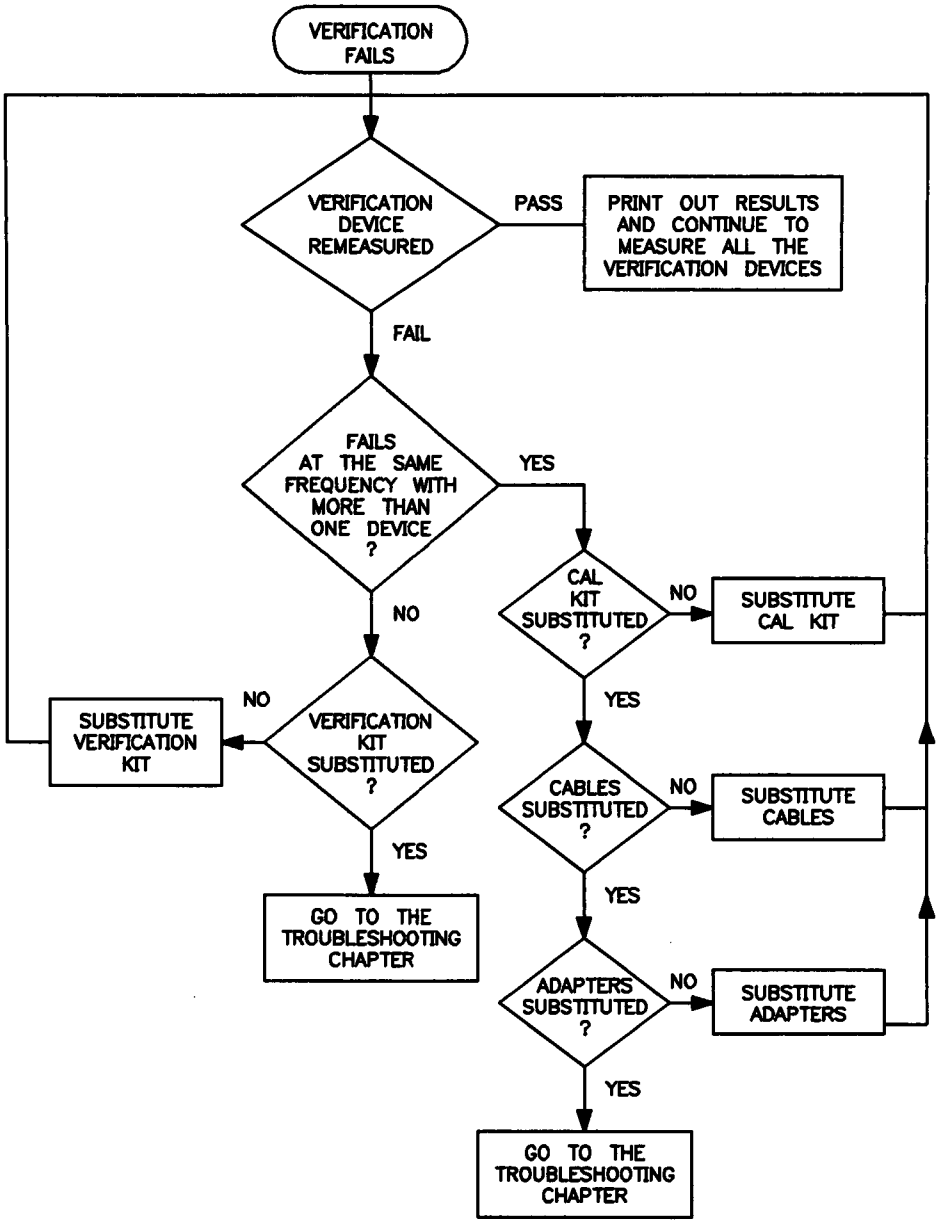
4. Refer to *Troubleshooting*.

If the System Fails the Total System Uncertainty Test

- Disconnect and reconnect the device that failed the verification. Then remeasure the device.

If the performance verification still fails:

- Continue to measure the rest of the verification devices and print out the results of all four measurement parameters.
- Print the error terms and examine them for anomalies near the failure frequencies. (Refer to the "Error Terms" chapter in this manual.)
- Make another measurement calibration and follow the flow chart on the following page.


VERIFICATION FAILS
VERIFICATION DEVICE REMEASURED
PASS
PRINT OUT RESULTS AND CONTINUE TO MEASURE ALL THE VERIFICATION DEVICES
FAIL
FAILS AT THE SAME FREQUENCY WITH MORE THAN ONE DEVICE ?
YES
NO
CAL KIT SUBSTITUTED ?
NO
SUBSTITUTE CAL KIT
YES
CABLES SUBSTITUTED ?
NO
SUBSTITUTE CABLES
YES
ADAPTERS SUBSTITUTED ?
NO
SUBSTITUTE ADAPTERS
YES
GO TO THE TROUBLESHOOTING CHAPTER
VERIFICATION KIT SUBSTITUTED ?
NO
SUBSTITUTE VERIFICATION KIT
YES
GO TO THE TROUBLESHOOTING CHAPTER

Connecting the Airlines

This section provides step–by–step procedures for connecting 2.4 mm and 3.5 mm airlines and mismatch airlines.

Before making any connections, take care to avoid electrostatic discharge by wearing a grounded wrist strap. In addition, it is good practice to grasp the outer shell of the test port connector just before you make any connections to the test set. This discharges any static electricity on your body by providing a conductive path to an earth ground.

The following procedure applies to the 50Ω airline and the 25Ω mismatch airline. Before proceeding with the connection procedure, assemble the airline and center conductor by removing the center conductor from its plastic case and inserting the female end of the center conductor into the outer conductor so that the female end of the center conductor is toward the end of the outer conductor without the connector nut (leave the protective cap on the male end of the outer conductor to prevent the center conductor from falling out of the outer conductor). Replace the protective cap on the female end of the airline until you are ready to use the airline.

Follow the *exact* sequence of steps when connecting these devices.

CAUTION

Be especially careful not to drop either the center conductor or the outer conductor when handling these airlines. Irreparable damage will result if these devices are dropped.

Connect the airline as follows:

1. Always connect the female end of the center conductor first. Remove the protective cap from the female end of the outer conductor (leave the cap on the other end for now).

CAUTION

During this procedure, you will be touching the exposed center conductor of the test port with the center conductor of the airline. Ground yourself to prevent electrostatic discharge (ESD).

CAUTION

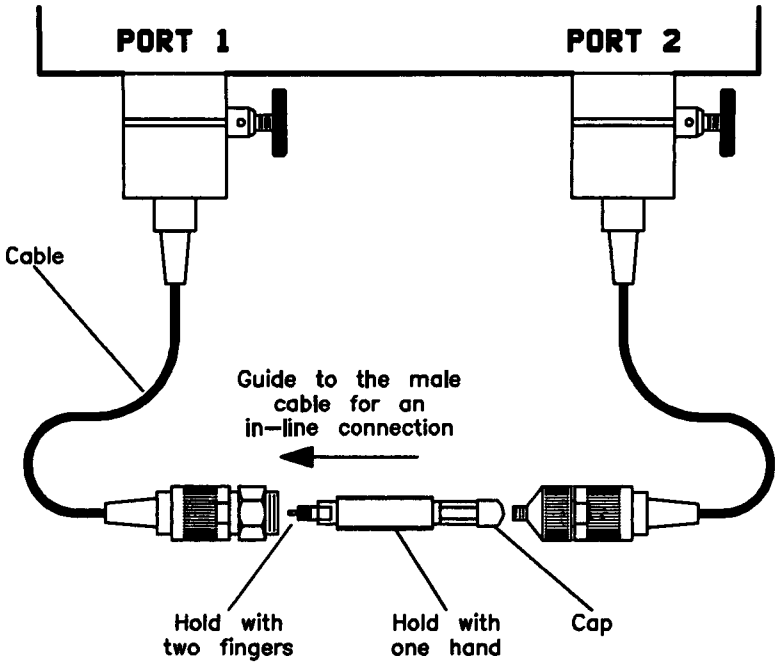


Figure 4–10. Aligning the Center Conductor

2. Pull the center conductor from the outer conductor just enough to be able to hold the center conductor with two fingers while holding the outer conductor with the other hand. Guide the center and outer conductors to the male cable for an in–line connection. Mate the female end of the airline center conductor with the center conductor of the cable connector.

3. Connect the outer conductor of the airline to the outer conductor of the cable connector. Hand tighten this connection.

4. Mate the male end of the airline with the cable connector. Hand tighten this connection.

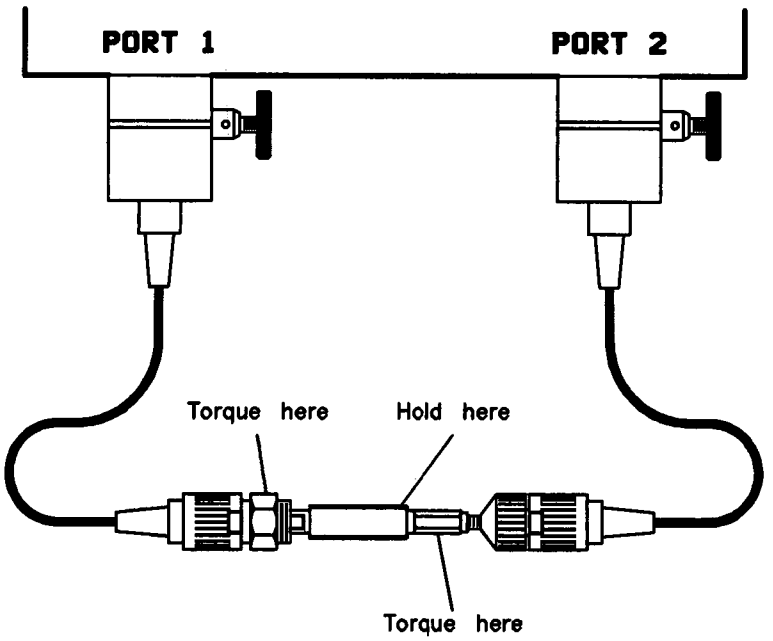


Figure 4–11. Torquing the Connection

5. Hold the plastic insulation cover on the airline to keep the airline from turning and torque each connection 90 N–cm, (8 in–lb). It may be necessary to use a 5/16 inch open end wrench to hold the airline stationary if it can not be prevented from rotating by hand.

To disconnect the airline:

1. Remove one cable from the airline and replace the plastic cap on the airline to prevent the center conductor from sliding out of the outer conductor. If the center conductor of the airline does not disengage from the cable center conductor, gently pull the airline center conductor from the cable center conductor and push the airline center conductor back inside the outer conductor of the airline.

2. Remove the cable from the other end of the airline. If the airline will not be used again immediately, slide the center conductor out of the outer conductor and store the center conductor in the plastic case provided. Replace the other plastic cap on the outer conductor and store the center and outer conductors in the foam lined storage case.

COMPARING SYSTEM MEASUREMENT UNCERTAINTIES FOR THE PERFORMANCE VERIFICATION DEVICES

Your verification kit was shipped with two sets of device characterization data for the components in the kit. One is the device characterization data for the HP 8510. The uncertainties represent the factory test system's uncertainties. The second is the device characterization data for the HP 8722. The uncertainty data here is specific to the type of calibration kit you are using and represents the total system measurement uncertainty.

Since the devices in your kit were characterized on the factory 8510 system, it is possible to use these two sets of device characterization data to determine your system measurement uncertainty for each of the verification devices.

The comparison calculation can be done by following the steps below:

1. Extract a factory measurement uncertainty value from the characterization data sheet for the HP 8510 (shipped with the verification kit).

2. Subtract the value in step 1 from the total measurement uncertainty value for the specific cal kit used, printed on the device characterization data sheet for the 8722 (shipped with the verification kit).

HEWLETT-PACKARD DEVICE CHARACTERIZATION DATA SHEET FOR 8510

Date : 15 Apr 1991, Kit: 85053B, Serial No. 2815A00914
Item : 20 dB ATTENUATOR, 85053-60001, Serial No. 02045
Ambient conditions: 23 deg. C., Uncertainties for Factory Test System
PORT IDENTIFICATION : With the device label facing the user:
Port 1 (A) is on the left and Port 2 (B) is on the right

	S21				S12			
FREQ GHz	MAG db	UNC +/-	ANG deg	UNC +/-	MAG db	UNC +/-	ANG deg	UNC +/-
.045	-20.014	.027	-1.70	.24	-20.013	.027	-1.76	.24
1.500	-20.032	.026	-61.12	.32	-20.033	.026	-61.11	.32
2.000	-20.037	.025	-81.38	.35	-20.038	.026	-81.38	.35
3.000	-20.055	.025	-122.00	.41	-20.057	.025	-121.96	.41
4.500	-20.079	.027	177.19	.51	-20.078	.027	177.23	.51
6.000	-20.102	.027	116.39	.60	-20.106	.027	116.42	.60
7.500	-20.131	.027	55.61	.69	-20.137	.027	55.64	.69
8.000	-20.144	.027	35.35	.72	-20.143	.027	35.36	.72
9.000	-20.159	.034	-5.17	.83	-20.161	.034	-5.12	.83
10.500	-20.198	.034	-65.93	.92	-20.196	.034	-65.89	.92
12.000	-20.227	.034	-126.72	1.01	-20.232	.034	-126.66	1.01
13.500	-20.264	.033	172.58	1.08	-20.265	.033	172.60	1.08
15.000	-20.301	.033	111.85	1.18	-20.307	.033	111.85	1.18
16.500	-20.339	.034	51.09	1.27	-20.338	.034	51.12	1.27
18.000	-20.363	.034	-9.67	1.36	-20.363	.034	-9.61	1.36
19.500	-20.385	.034	-70.46	1.45	-20.392	.034	-70.38	1.46
20.000	-20.399	.034	-90.63	1.48	-20.400	.034	-90.67	1.49
21.000	-20.405	.054	-131.31	1.69	-20.419	.054	-131.74	1.69
22.500	-20.433	.058	167.98	1.81	-20.420	.058	167.95	1.81
24.000	-20.428	.053	106.87	1.93	-20.436	.051	107.00	1.93
25.500	-20.429	.070	45.92	2.07	-20.436	.068	45.92	2.06
26.500	-20.440	.077	5.18	2.18	-20.441	.075	5.14	2.17

	S11				S22			
FREQ GHz	MAG lin	UNC +/-	ANG deg	UNC +/-	MAG lin	UNC +/-	ANG deg	UNC +/-
.045	.00148	.00238	-178.77	180.00	.00288	.00327	177.42	180.00
1.500	.00199	.00238	108.58	180.00	.00436	.00327	100.44	40.84
2.000	.00209	.00238	82.76	180.00	.00522	.00327	73.56	39.15
3.000	.00123	.00237	55.74	180.00	.00590	.00327	24.98	34.16
4.500	.00038	.00317	78.55	-180.00	.00679	.00391	-42.54	35.77
6.000	.00203	.00317	126.66	180.00	.00740	.00391	-99.78	32.68
7.500	.00337	.00317	88.24	70.36	.00715	.00391	-143.51	34.88
8.000	.00346	.00317	66.36	66.83	.00651	.00391	-158.97	37.92
9.000	.00332	.00342	36.59	180.00	.00589	.00401	171.81	53.05
10.500	.00228	.00342	-43.42	180.00	.00238	.00488	169.62	180.00
12.000	.00432	.00342	-158.86	52.55	.00435	.00401	-168.19	68.59
13.500	.00958	.00344	145.05	21.47	.00821	.00482	158.94	30.88
15.000	.01451	.00345	99.88	14.02	.01264	.00483	116.21	20.35
16.500	.01703	.00348	55.19	12.00	.01576	.00484	69.83	16.78
18.000	.01611	.00346	6.02	12.89	.01766	.00485	23.13	15.33
19.500	.01173	.00345	-54.00	17.39	.01877	.00485	-24.86	14.71
20.000	.01068	.00344	-82.18	19.11	.01778	.00485	-43.91	15.53
21.000	.01030	.00398	-148.72	22.55	.01565	.00434	-76.69	18.63
22.500	.01847	.00394	126.00	12.63	.01055	.00434	-148.84	26.80
24.000	.02845	.00399	66.98	8.13	.00488	.00434	148.97	65.69
25.500	.04035	.00405	14.29	6.12	.01038	.00439	11.34	27.95
26.500	.04713	.00410	-20.35	5.35	.01676	.00444	-48.49	19.38

* Note: Uncertainties for frequency data points below 500 Mhz do not apply when used with 8512 or 8514 test sets.

HEWLETT-PACKARD DEVICE CHARACTERIZATION DATA SHEET FOR 8720

Date : 16 Apr 1991, Kit: 85053B, Serial No. 2815A00914
Item : 20 dB ATTENUATOR, 85053-60001, Serial No. 02045
Total measurement uncertainty when calibrated with HP85052D kit.
Ambient conditions: 23 deg. C.
PORT IDENTIFICATION : With the device label facing the user:
Port 1 (A) is on the left and Port 2 (B) is on the right

	S21				S12			
FREQ GHz	MAG db	UNC +/-	ANG deg	UNC +/-	MAG db	UNC +/-	ANG deg	UNC +/-
.130	-20.010	.291	-5.35	1.98	-20.014	.291	-5.37	1.98
.250	-20.013	.231	-10.28	1.63	-20.017	.231	-10.30	1.63
.500	-20.010	.210	-20.48	1.57	-20.022	.210	-20.46	1.57
.750	-20.022	.223	-30.64	1.74	-20.027	.224	-30.64	1.74
1.000	-20.024	.222	-40.83	1.81	-20.030	.222	-40.74	1.81
1.250	-20.027	.222	-50.95	1.88	-20.032	.222	-50.96	1.89
1.500	-20.032	.221	-61.11	1.96	-20.033	.222	-61.11	1.96
2.000	-20.037	.223	-81.38	2.12	-20.038	.222	-81.38	2.12
3.000	-20.055	.266	-122.00	2.72	-20.057	.266	-121.96	2.72
4.500	-20.079	.287	177.19	3.20	-20.078	.288	177.23	3.21
6.000	-20.102	.288	116.39	3.68	-20.106	.288	116.42	3.68
7.500	-20.131	.288	55.61	4.15	-20.137	.288	55.64	4.15
8.000	-20.144	.288	35.35	4.31	-20.143	.288	35.36	4.31
9.000	-20.159	.344	-5.17	5.13	-20.161	.344	-5.12	5.13
10.500	-20.198	.343	-65.93	5.80	-20.196	.343	-65.89	5.80
12.000	-20.227	.344	-126.72	6.08	-20.232	.344	-126.66	6.08
13.500	-20.264	.346	172.58	6.56	-20.265	.345	172.60	6.55
15.000	-20.301	.349	111.85	7.05	-20.307	.349	111.85	7.05
16.500	-20.339	.351	51.09	7.54	-20.338	.351	51.12	7.54
18.000	-20.363	.352	-9.67	8.02	-20.363	.352	-9.61	8.02
19.500	-20.385	.350	-70.46	8.48	-20.392	.351	-70.38	8.48
20.000	-20.399	.350	-90.63	8.64	-20.400	.350	-90.67	8.64

	S11				S22			
FREQ GHz	MAG lin	UNC +/-	ANG deg	UNC +/-	MAG lin	UNC +/-	ANG deg	UNC +/-
.130	.00161	.01473	177.19	180.00	.00322	.01565	174.59	180.00
.250	.00155	.01399	170.66	180.00	.00313	.01491	166.65	180.00
.500	.00174	.01371	160.56	180.00	.00354	.01483	152.96	180.00
.750	.00175	.01365	149.25	180.00	.00351	.01456	141.21	180.00
1.000	.00186	.01362	136.64	180.00	.00389	.01454	121.55	180.00
1.250	.00189	.01361	120.97	180.00	.00424	.01454	112.77	180.00
1.500	.00199	.01361	108.58	180.00	.00436	.01453	100.44	180.00
2.000	.00209	.01360	82.76	180.00	.00522	.01454	73.55	180.00
3.000	.00123	.01635	55.74	180.00	.00590	.01731	24.98	180.00
4.500	.00038	.01713	79.55	180.00	.00679	.01796	-42.54	180.00
6.000	.00203	.01716	126.66	180.00	.00740	.01797	-99.78	180.00
7.500	.00337	.01717	88.24	180.00	.00715	.01798	-143.51	180.00
8.000	.00346	.01717	66.36	180.00	.00651	.01795	-158.97	180.00
9.000	.00332	.02081	36.59	180.00	.00589	.02145	171.81	180.00
10.500	.00228	.02078	-43.42	180.00	.00238	.02137	169.62	180.00
12.000	.00432	.02084	-158.86	180.00	.00435	.02142	-168.19	180.00
13.500	.00958	.02098	145.05	180.00	.00821	.02153	158.94	180.00
15.000	.01451	.02113	99.88	180.00	.01264	.02166	116.21	180.00
16.500	.01703	.02120	55.19	180.00	.01576	.02175	69.83	180.00
18.000	.01611	.02117	6.02	180.00	.01766	.02181	23.13	180.00
19.500	.01173	.02104	-54.00	180.00	.01877	.02184	-24.86	91.04
20.000	.01068	.02101	-82.19	180.00	.01778	.02181	-43.91	180.00

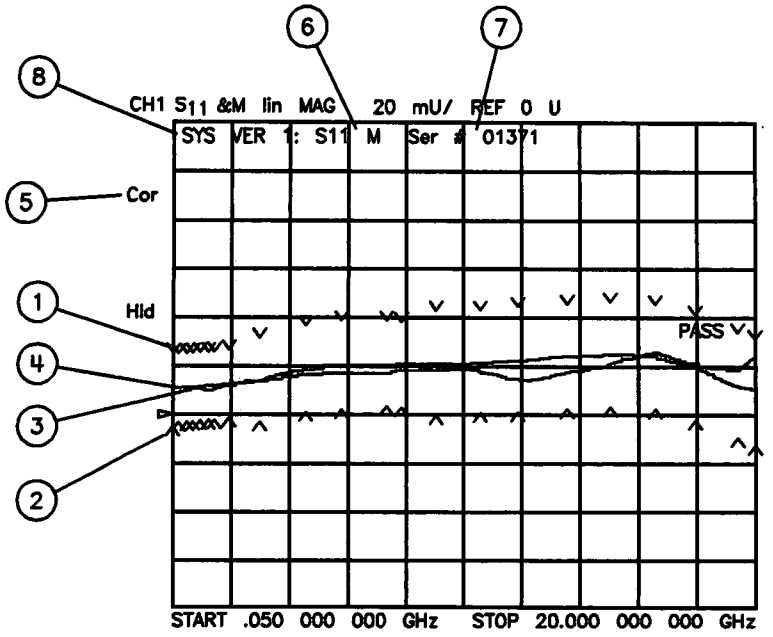
Freq GHz	Total Uncertainty	–	Factory Uncertainty	=	System Measurement Uncertainty
2.000	0.222	–	0.026	=	0.196
3.000	0.266	–	0.025	=	0.241

Example 4–1. Table for Comparing Measurement Uncertainties

Freq GHz	Total Uncertainty	–	Factory Uncertainty	=	System Measurement Uncertainty

Example 4–2. Table for Comparing Measurement Uncertainties

How to Interpret the Verification Results



1. Upper limit line as defined by the total system uncertainty specifications.
2. Lower limit line as defined by the total system uncertainty specifications.
3. Data measured at the factory.
4. Results of magnitude measurement as measured in performance verification.
5. Correction is turned on.
6. Measurement parameter S11 magnitude.
7. Serial number of device.
8. Device being measured : sys ver 1 = 20 dB attenuator.

How to Interpret the Verification Results

STIMULUS GHz	CH1 S11	Margin	Upper Lim	Lower Lim
.130 000 000	9.3369 mU	13.702 mU	25.353 mU	-4.3652 mU
.250 000 000	8.1229 mU	11.341 mU	25.041 mU	-3.218 mU
.500 000 000	9.6231 mU	12.569 mU	24.737 mU	-2.9459 mU
.750 000 000	10.47 mU	13.1 mU	24.937 mU	-2.6303 mU
1.000 000 000	9.7561 mU	12.15 mU	25.135 mU	-2.3934 mU
1.250 000 000	8.7829 mU	10.776 mU	25.528 mU	-1.9928 mU
1.500 000 000	10.391 mU	12.09 mU	25.821 mU	-1.6984 mU
2.000 000 000	11.921 mU	12.807 mU	26.65 mU	-885.74 U
3.000 000 000	13.952 mU	16.163 mU	30.892 mU	-2.2108 mU
4.500 000 000	16.833 mU	15.771 mU	35.927 mU	1.0622 mU
6.000 000 000	17.266 mU	14.421 mU	37.775 mU	2.845 mU
7.500 000 000	17.797 mU	14.538 mU	38.198 mU	3.2575 mU
8.000 000 000	19.783 mU	16.407 mU	38.32 mU	3.3765 mU
9.000 000 000	19.879 mU	20.052 mU	42.518 mU	-172.32 U
10.500 000 000	18.365 mU	17.886 mU	43.209 mU	479.09 U
12.000 000 000	14.19 mU	12.571 mU	44.421 mU	1.6187 mU
13.500 000 000	17.699 mU	14.365 mU	46.252 mU	3.3345 mU
15.000 000 000	21.39 mU	17.131 mU	47.236 mU	4.2593 mU
16.500 000 000	26.877 mU	19.149 mU	46.027 mU	3.1305 mU
18.000 000 000	20.889 mU	20.664 mU	41.553 mU	-1.0549 mU
19.500 000 000	19.535 mU	14.08 mU	33.616 mU	-8.5122 mU
20.000 000 000	25.054 mU	6.2639 mU	31.318 mU	-10.677 mU

1. Frequency of the data points.
2. Results of magnitude measurement as measured in the performance verification.
3. Upper limit line as defined by the total system uncertainty specification.
4. Lower limit line as defined by the total system uncertainty specification.
5. Difference between the measured results and the limit line. A positive number indicates a pass. An asterisk (*) indicates a fail.

MEASUREMENT UNCERTAINTIES

INTRODUCTION

In any measurement, certain measurement errors associated with the system add uncertainty to the measured results. This uncertainty defines how accurately a device under test (DUT) can be measured.

Network analysis measurement errors can be separated into two types: raw and residual. The raw error terms are the errors associated with the uncorrected system that are called systematic (repeatable), random (non−repeatable), and drift errors. The residual error terms are the errors that remain after a measurement calibration.

The error correction procedure, also called measurement calibration, measures a set of calibration devices with known characteristics. It uses the measurement results to effectively remove systematic errors, using the vector math capabilities of the analyzer. The residual systematic errors remain after error correction, primarily due to the limitations of how accurately the electrical characteristics of the calibration devices can be defined and determined. Also, the random (non−repeatable) and drift errors, cannot be corrected because they cannot be quantified and measured during the measurement calibration and device measurement. However, the effects of random errors can be reduced through averaging. Random errors, that occur during a measurement calibration, are part of the error correction and become systematic errors when the calibration is turned on. For this reason, it is best to use a large number of averages during measurement calibration to reduce to the effect of the random errors. The averaging may then be reduced for device measurement. The residual systematic errors along with the random and drift errors continue to affect measurements after error correction, adding an uncertainty to the measurement results. Therefore, measurement uncertainty is defined as the combination of the residual systematic (repeatable), random (non−repeatable), and drift errors in the measurement system after error correction.

The following measurement uncertainty equations and system error models (flowgraphs) show the relationship of the systematic, random, and drift errors. These are useful for predicting overall measurement performance.

SOURCES OF MEASUREMENT ERRORS

Sources of Systematic Errors

The residual (after measurement calibration) systematic errors result from imperfections in the calibration standards, the connector interface, the interconnecting cables, and the instrumentation. All measurements are affected by dynamic accuracy and frequency error effects. For reflection measurements, the associated residual errors are effective directivity, effective source match, and effective reflection tracking. For transmission measurements, the additional residual errors are effective crosstalk, effective load match, and effective transmission tracking.

The listing below shows the abbreviations used for residual systematic errors that are in the error models and uncertainty equations.

- Efd, Erd = effective directivity
- Efs, Ers = effective source match
- Efr, Err = effective reflection tracking
- Efc, Erc = effective crosstalk
- Efl, Erl = effective load match
- Eft, Ert = effective transmission tracking
- Crm, Ctm = cable stability (deg./GHz)
- Ab1, Ab2 = dynamic accuracy
- F = frequency

The sources for dynamic accuracy error effects are from errors during internal self–calibration routines, gain compression in the microwave frequency converter (sampler) at high signal levels, errors generated in the synchronous detectors, localized non–linearities in the IF filter system, and from LO leakage into the IF signal paths.

Sources of Random Errors

The random error sources are noise, connector repeatability and dynamic accuracy. There are two types of noise in any measurement system: low level noise (noise floor) and high level noise (phase noise of the source).

Low level noise is the broadband noise floor of the receiver which can be reduced through averaging or by changing the IF bandwidth.

High level noise or jitter of the trace data is due to the noise floor and the phase noise of the LO source inside the test set.

Connector repeatability is the random variation encountered when connecting a pair of RF connectors. Variations in both reflection and transmission can be observed.

The listing below shows the abbreviations used for random errors in the error models and uncertainty equations.

- Rnt = raw noise on trace (rms)
- Rnf = raw noise on floor (rms)
- Crr1 = port 1 connector reflection repeatability error
- Crt1 = port 1 connector transmission repeatability error
- Crr2 = port 2 connector reflection repeatability error
- Crt2 = port 2 connector transmission repeatability error

Sources of Drift Errors

Drift has two categories: frequency drift of the signal source and instrumentation drift. Instrumentation drift affects the magnitude and phase of both reflection and transmission measurements.

The primary causes for instrumentation drift are the thermal expansion characteristics of the interconnecting cables within the test set and the conversion stability of the microwave frequency converter.

The list below shows the drift errors in the error models and uncertainty equations.

- Dmxbx, Dmsax = drift magnitude
- Dpxbx, Dpsax = drift phase
- Dpfxbx, Dpfsax = drift phase/f

Sources of Additional Measurement Errors

Two additional categories of measurement errors are connection techniques and contact surfaces.

The connection techniques category includes torque limits, flush setting of sliding load center conductors, and handling procedures for beadless airlines.

The contact surfaces category includes cleaning procedures, scratches, worn plating, and rough seating.

These types of errors are not accounted for in the uncertainty analysis.

MEASUREMENT UNCERTAINTY EQUATIONS

Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends on its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst case (—180 to +180 degrees). Random errors such as noise and connector repeatability are generally combined in a root–sum–of–the–squares (RSS) manner.

Due to the complexity of the calculations, the performance verification/specifications software calculates the system measurement uncertainty. The following equations are representative of the equations the performance verification/specifications software uses to generate the system measurement uncertainty plots and tables.

Reflection Uncertainty Equations

Total Reflection Magnitude Uncertainty (Erm)

An analysis of the error model in NO TAG yields an equation for the reflection magnitude uncertainty. The equation contains all of the first order terms and the significant second order terms. The terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms and the S−parameters are treated as linear absolute magnitudes.

Reflection magnitude uncertainty (forward direction) =

$$Erm = Systematic + \sqrt{(Random)^2 + (Drift\ \&\ Stability)^2}$$

$$Systematic = Efd + Efr\ S11 + Efs\ S11^2 + S21\ S12\ Efl + Ab1\ S11$$

$$Random = \sqrt{(Cr)^2 + (Rr)^2 + (Nr)^2}$$

$$Cr = \sqrt{(Crm1)^2 + (2Ctm1S11)^2 + (Crm1S11)^2 + (Crm2S21S12)^2}$$

$$Rr = \sqrt{(Crr1 + 2Crt1S11 + Crr1S11^2)^2 + (Crr2S21S12)^2}$$

$$Nr = \sqrt{(EfntS11)^2 + Efnf^2}$$

$$Drift\ \&\ Stability = Dm1b1\ S11$$

where

- Efnt = effective noise on trace
- Efnf = effective noise floor
- Crt1 = connector repeatability (transmission)
- Crr1 = connector repeatability (reflection)
- Ctm1 = cable 1 transmission magnitude stability
- Crm1 = cable 1 reflection magnitude stability
- Crm2 = cable 2 reflection magnitude stability
- Dms1 = drift magnitude/°C source to port 1
- Efs = effective source match error
- Efr = effective reflection tracking error
- Efl = effective load match error
- Efd = effective directivity error
- Crr2 = Connector repeatability (reflection)

The detailed equation for each of the previous terms is derived from the signal flow model in NO TAG.

Reflection Phase Uncertainty (Erp)

Reflection phase uncertainty is determined from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to thermal drift of the total system, port 1 cable stability, and phase dynamic accuracy.

$$Erp = Arcsin\ (Erm/S11) + 2Cpf1 \times f + Dps1 + Dpfs1 \times f$$

where

Cpf1 = cable phase/frequency port 1
Dps1 = drift phase/degree source to port 1
Dpfs1 = drift phase/degree/frequency source to port 1

Transmission Uncertainty Equations

Transmission Magnitude Uncertainty (Etm)

An analysis of the error model in NO TAG yields an equation for the transmission magnitude uncertainty. The equation contains all of the first order terms and some of the significant second order terms. The terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms are treated as linear absolute magnitudes.

Transmission magnitude uncertainty (forward direction) = Etm =

$$Ert = Systematic + \sqrt{(Random)^2 + (Drift\ \&\ Stability)^2}$$

$$Systematic = Efc + (Ef_t + EfsS11 + EflS22 + EfsEflS21S12 + Ab2)\ S21$$

$$Random = \sqrt{(Ct)^2 + (Rt)^2 + (Nt)^2}$$

$$Ct = S21\ \sqrt{(Ctm1)^2 + (Ctm2)^2 + (Crm1S11)^2 + (Crm2S22)^2}$$

$$Rt = S21\ \sqrt{(Crt1)^2 + (Crt2)^2 + (Crr1S11)^2 + (Crr2S22)^2}$$

$$Nt = \sqrt{(EfntS21)^2 + Efnf^2}$$

$$Drift\ \&\ Stability = Dm2b2S21$$

where

Crt2 = Connector repeatability (transmission) port 2
Crr2 = Connector repeatability (reflection) port 2
Efnt = effective noise on trace
Efnf = effective noise floor
Crr1 = connector repeatability (relection)
Crt1 = connector repeatability (transmission)
Ctm1 = cable 1 transmission magnitude stability
Crm1 = cable 1 reflection magnitude stability
Ctm2 = cable 2 transmission magnitude stability
Crm2 = cable 2 reflection magnitude stability
Dms1 = drift magnitude/°C source to port
Efs = effective source match error
Eft = effective transmission tracking error
Efl = effective load match error
Efc = effective crosstalk error

The detailed equation for each of the above terms is derived from the signal flow model in NO TAG.

Transmission Phase Uncertainty (Etp)

Transmission phase uncertainty is calculated from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to phase dynamic accuracy, cable phase stability, and thermal drift of the total system.

$$Etp = Arsin\ (Ert/S21) + Cpf1 \times f + Cpf2 \times f + Dps1 + Dpfs1 \times f$$

where

Cpf1 = Cable phase/frequency port 1
Cpf2 = Cable phase/frequency port 2
Dps1 = drift phase/degree source to port 1
Dpfs1 = drift phase/degree/frequency source to port 1

DYNAMIC ACCURACY

On the following page is a typical dynamic accuracy and noise curve for the HP 8722. This curve is based on statistical samples of units built at the factory with an IF BW of 10 Hz.

Since this curve combines the effects of dynamic accuracy and noise, if used in uncertainty calculations, the effects of the noise terms in the corresponding equations can be eliminated.

$$\text{Dynamic Accuracy (linear)} = 10^{\frac{\pm\ \text{DynAcc(dB)}}{20}} \mp 1$$

$$\text{Dynamic Accuracy (dB)} = 20log\ (1 \pm \text{Dynamic Accuracy (linear)})$$

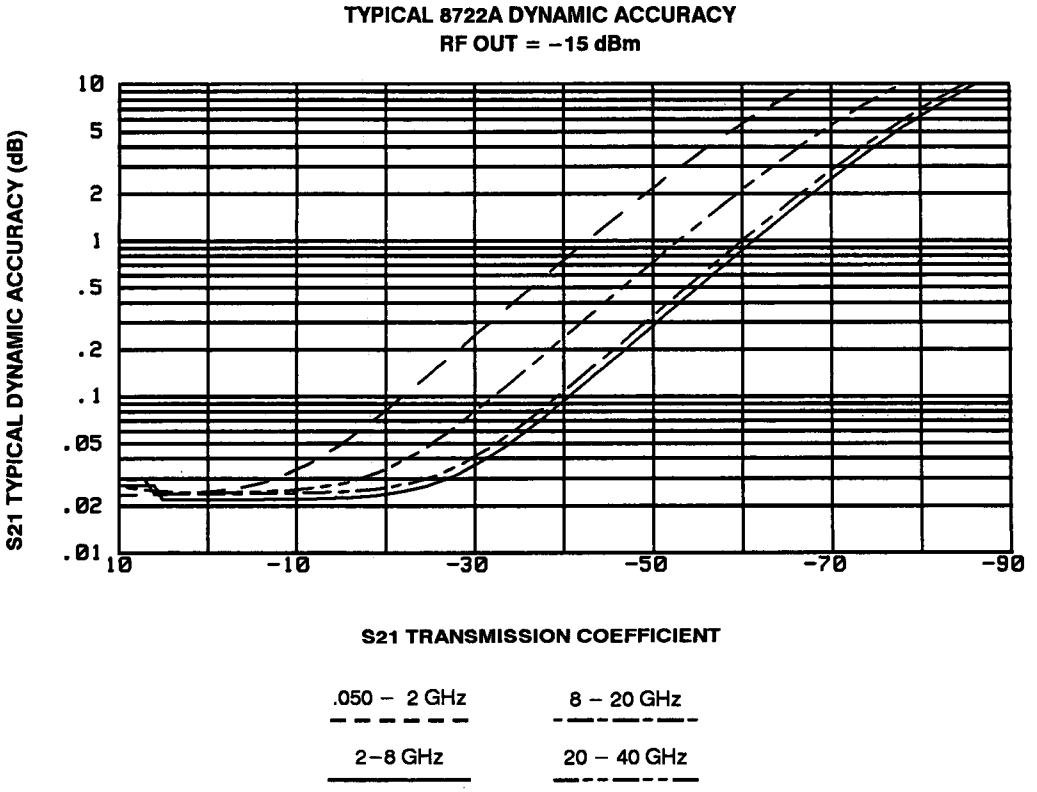


Figure 4–12

DETERMINING EXPECTED SYSTEM PERFORMANCE

The uncertainty equations, dynamic accuracy calculations in this section, and tables of system performance values from the *Specifications* section can be used to calculate the expected system performance. The following pages explain how to determine the residual errors of a particular system and combine them to obtain total error–corrected residual uncertainty values, using worksheets provided. The uncertainty graphs in the *Specifications* section are examples of the results that can be calculated using this information.

Procedures

Table 4–6 is a worksheet used to calculate the residual uncertainty in transmission and reflection measurements. Determine the linear values of the residual error terms and the nominal linear S–parameter data of the device under test as described below and enter these values in the worksheets. Then use the instructions and equations in the worksheets to combine the residual errors for total system uncertainty performance. The resulting total measurement uncertainty values have a confidence factor of 99.9%.

S–parameter Values. Convert the S–parameters of the test device to their absolute linear terms.

Noise Floor and Crosstalk. If a full 2–port calibration is performed, the residual crosstalk term can be ignored. Connect an impedance–matched load to each of the test ports and measure S_{21} or S_{12}. Use the statistic function to measure the mean value of the trace. Use this value plus one standard deviation as the noise floor value of your system.

Dynamic Accuracy. Determine the absolute linear magnitude dynamic accuracy from the dynamic accuracy graph (Figure 4–12).

Other Error Terms. Depending on the connector type in your system, refer to residual error specifications in the *Specifications* section, and to Table 4–5 on page 4–48, to find the absolute linear magnitude of the remaining error terms.

Combining Error Terms. Combine the above terms using the reflection or transmission uncertainty equation in the worksheets.

Table 4–5. Typical Values Table

	7 mm	3.5 mm	Type–N	2.4 mm
Crr1 = port 1 Refl. Connector Repeat	–65 dB	–60 dB	–60 dB	–60
Crr2 = port 2	–65 dB	–60 dB	–60 dB	–60
Crt1 = port 1 trans connector repeat	–65 dB	–60 dB	–60 dB	–60
Crt2 = port 2	–65 dB	–60 dB	–60 dB	–60
Crm1 – Cbl refl mag stability port 1	– 60 dB	–54 dB	–60 dB	–50
Crm2 – cbl. refl mag stability port 2	–60 dB	–54 dB	–60 dB	–50
Ctm1 – cbl. tran mag stab port 1	± .03 dB	± .03 dB	± .01 dB	±.03 dB
Ctm2 – cbl. tran. mag stab port 2	± .03 dB	± .03 dB	± .01 dB	± .03 dB
Cpf1 – cable phase stab port 1 & port 2	± .09 deg/GHz	± .09 deg/GHz	± .1 deg/GHz	± .09 deg/GHz
$D_{ms1,2}$ – Magnitude Drift	0.0015/°C	0.0015/°C	0.0015/°C	0.0015°/°C
$D_{ps1,2}$ – Phase Drift	0.01°/°C	0.01°/°C	0.01°/°C	0.01°/°C
$D_{psf1,2}$ – Phase Drift with Temperature & Frequency	0.15°/°C	0.15°/°C	0.15°/°C	0.15°/°C

These numbers are taken from the 8510 Specification Software using the same cal, ver and cable kit configurations as in the 8722 specification section, i.e.: 3.5 = 85052B kit, 85133F, cables, 85053B verification kit.

Table 4–6. Measurement Uncertainty Worksheet (1 of 3)

In the columns below, enter the appropriate values for each term. Frequency: _____			
Error Term	**Symbol**	**dB Value**	**Linear Value**
S_{11}	S_{11}	_____	_____
S_{21}	S_{21}	_____	_____
S_{12}	S_{12}	_____	_____
S_{22}	S_{22}	_____	_____
Directivity	E_{fd}	_____	_____
Reflection tracking	E_{fr}	_____	_____
Source match	E_{fs}	_____	_____
Load match	E_{fl}	_____	_____
Transmission tracking	E_{ft}	_____	_____
Effective Crosstalk	E_{fc}	_____	_____
Dynamic accuracy (magnitude)	$Ab1, Ab2$	_____	_____
Noise floor[2]	E_{fnf}	_____	_____
High level noise[2]	E_{fnt}	_____	_____
Connector reflection repeatability port 1	C_{rr1}	_____	_____
Connector transmission repeatability port 1	C_{rt1}	_____	_____
Magnitude drift due to temperature	$D_{ms1, 2}$	_____	_____
Phase drift due to temperature	$D_{ps1, 2}$	_____	_____
Phase drift due to temperature and frequency	$D_{pfs1, 2}$	_____	_____
Cable reflection stability	C_{rm1}	_____	_____
Cable transmission stability	C_{rm2}	_____	_____
Connector reflection, repeatability port 2	C_{rr2}	_____	_____
Connector transmission repeatability, port 2	C_{rt2}	_____	_____
Cable phase/freq port 1	C_{pf1}	_____	_____
Cable phase/freq port 2	C_{pf2}	_____	_____

Table 4–6. Reflection Measurement Uncertainty Worksheet (2 of 3)

Magnitude **Combine Systematic Errors.** In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors to obtain the total sum of systematic errors.	
E_{fd}	____ = ____ (k)
$E_{fr} \times S_{11}$	____ x ____ = ____ (l)
$E_{fs} \times S_{11} \times S_{11}$	____ x ____ x ____ = ____ (m)
$E_{fl} \times S_{21} \times S_{12}$	____ x ____ x ____ = ____ (n)
$A_{b1} \times S_{11}$	____ x ____ = ____ (o)
Subtotal: k + l + m + n + o	____ + ____ + ____ + ____ + ____ = ____ (S)
Combine Random Errors. In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors in an RSS fashion to obtain a total sum of the random errors.	
$(E_{fnt} \times S_{11})^2 + E_{fnf}^2$	(____ x ____)^2 + ____ = ____ (w^2)
$(C_{rr1} + 2 \times C_{rt1} \times S_{11} + C_{rr1} \times S_{11}^2)^2$ $+(C_{rr2} \times S_{21} \times S_{12})^2$	(____ + 2 x ____ x ____ + ____ x ____ ^{2}) ^{2} + (____ x ____ x ____) ^{2} = ____ (x^2)
$C_{rm1}^2 + (2 \times C_{tm1} \times S_{11})^2 +$ $(C_{rm1} \times S_{11})^2 + (C_{rm1} \times S_{11})^2 +$ $(C_{rm2} \times S_{21} \times S_{12})^2$	____ ^{2} + (2 x ____ x ____) ^{2} + (____ x ____) ^{2} + (____ x ____) ^{2} + (____ x ____ x ____) = ____ (y^2)
$(D_{mb1} \times S_{11})^2$	(____ x ____) ^{2} = ____ (z^2)
$\sqrt{w^2 + x^2 + y^2 + z^2}$	$\sqrt{\quad}$ ____ + ____ + ____ + ____ = ____ (R)
Subtotal: S + R	____ + ____ = ____ (V_r)
Total Magnitude Errors:	
E_{rm}(linear) = V_r	____ = ____
E_{rm}(log) = Log (1±E_{rm}/S_{11})	20 Log (1± ____/____) = ____ dB
Phase	
E_{rp} = Arcsin (E_{rm}/S_{11}) + 2 x C_{pf1} x f + D_{ps1} + D_{pfs1} x f)	Arcsin (____/____) + 2x ____ + ____ + ____ = ____degrees

Table 4–6. Transmission Measurement Uncertainty Worksheet (3 of 3)

Magnitude **Combine Systematic Errors.** In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors to obtain the total sum of systematic errors.		
E_{fc}	____ = ____	(k)
$E_{ft} \times S_{21}$	____ x ____ = ____	(l)
$E_{fs} \times S_{11} \times S_{21}$	____ x ____ x ____ = ____	(m)
$E_{fl} \times S_{22} \times S_{21}$	____ x ____ x ____ = ____	(n)
$E_{fs} \times E_{fl} \times S_{21}^2 \times S_{12}$	____ x ____ x ____ x ____ = ____	(o)
$A_{b2} \times S_{21}$	____ x ____ = ____	(p)
Subtotal: k + l + m + n + o	____ + ____ + ____ + ____ + ____ = ____	(S)
Combine Random Errors. In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors in an RSS fashion to obtain a total sum of the random errors.		
$(E_{fnt} \times S_{21})^2 + E_{fnf}^2$	(____ x ____)^2 x ____ ^{2}= ____	(w^2)
$S_{21}^2 (C_{rt1}^2 + C_{rt2}^2 + (C_{rr1} \times S_{11})^2 + (C_{rr2} \times S_{22})^2)$	____ ^{2} (____ ^{2} + ____ ^{2} + (____ x ____)^2 + (____ x ____)^2) = ____	(x^2)
$S_{21}^2 (C_{tm1}^2 + C_{tm2}^2 + (C_{rm1} \times S_{11})^2 + (C_{rm2} \times S_{22})^2)$	____ ^{2} (____ ^{2} + ____ ^{2} + (____ x ____)^2 + (____ x ____)^2) = ____	(y^2)
$(D_{m2b2} \times S_{21})^2$	(____ x ____)^2 = ____	(z^2)
$\sqrt{w^2 + ^2x + ^2y + ^2z}$	$\sqrt{\quad}$ ____ + ____ + ____ + ____ = ____	(R)
Subtotal: S + R	____ + ____ = ____	(V_r)
Total Magnitude Errors:		
E_{rm}(linear) = V_r	____ = ____	
E_{rm}(log) = Log (1±E_{rm}/S_{11})	20 Log (1± ____/____) = ____	dB
Phase		
E_{tp} = Arcsin (E_{tm}/S_{21}) + C_{pf1} x f+ C_{pf2} x f+ D_{ps1} + D_{pfs1} x f	Arcsin (____/____) + ____ + ____ + ____ = ____degrees	

TOTAL SYSTEM PERFORMANCE TEST RECORD

The complete system performance verification record includes the printout from the total system uncertainty test, this test record, and a certificate of calibration.

Use this sheet to record the results of the frequency tests. You may wish to copy this sheet to retain it as a master.

Performance Test Record (1 of 3)

Test Facility _____ Report Number _____

_____ Date _____

_____ Date of Last System Calibration _____

_____

Tested by _____ Customer _____

Model _____ Calibration Kit S/N _____ Verification Kit Model _____

Serial Number _____ Test Port Cables _____ Verification Kit S/N _____

Calibration Kit _____ Measurement Calibration Technique _____

Ambient temperature _____ °C Relative Humidity _____

Ambient temperature at measurement calibration _____ °C

Ambient temperature at performance verification _____ °C

Test Equipment Used	Model Number	Trace Number	Cal Due Date
1. Frequency Counter			
2. Verification Kit			
3.			

Special Notes: This system verification applies to total measurement uncertainty and frequency accuracy specifications.

Test Description	Minimum	Results	Maximum	Measurement Uncertainty[1]
Frequency Accuracy				
25.5 GHz	25.499745 GHz	_____	25.00255 GHz	76,500
Power Level				
8722A Full Band	−18 dBm	_____	−12	.3 dB
8722C				
0.05−2.0 GHZ	−3.5 dBm	_____	+3.5	.3 dB
2.0−8.0 GHz	−3.5 dBm	_____	+3.5	.3 dB
8.0−26.5 GHz	−3.5 dBm	_____	+3.5	.3 dB
26.5−40[2] GHZ	−8.5 dBm	_____	−1.5	.3 dB

1. The measurement uncertainty is based on equipment specified in Table 1−3 in the *Service and Overview* section.
2. On option 003, instruments applicable to port 1 only.

Test Description	Minimum		Results Port 1	Results Port 2	Measurement Uncertainty
Dynamic Range					
Freq. range (GHz)	8722A	8722C			
0.05 − 2.0	61 dB	76 dB	_____	_____	3 dB
2.0 − 8.0	78 dB	98 dB	_____	_____	3 dB
8.0 − 20	76 dB	93 dB*	_____	_____	3 dB
20 − 40	71 dB	87 dB	_____	_____	3 dB

* To 26.5 GHz

TOTAL SYSTEM PERFORMANCE TEST RECORD
OPTION 003

The complete system performance verification record includes the printout from the total system uncertainty test, this test record, and a certificate of calibration.

Use this sheet to record the results of the frequency tests. You may wish to copy this sheet to retain it as a master.

Performance Test Record Option 003 (1 of 3)

Test Facility _____ Report Number _____

_____ Date _____

_____ Date of Last System Calibration _____

_____ _____

Tested by _____ Customer _____

Model _____ Calibration Kit S/N _____ Verification Kit Model _____

Serial Number _____ Test Port Cables _____ Verification Kit S/N _____

Calibration Kit _____ Measurement Calibration Technique _____

Ambient temperature _____ °C Relative Humidity _____

Ambient temperature at measurement calibration _____ °C

Ambient temperature at performance verification _____ °C

Test Equipment Used	Model Number	Trace Number	Cal Due Date
1. Frequency Counter	_____	_____	_____
2. Verification Kit	_____	_____	_____
3.	_____	_____	_____

Special Notes: This system verification applies to total measurement uncertainty and frequency accuracy specifications.

Performance Test Record Option 003 (2 of 3)

Test Description	Minimum	Results	Maximum	Measurement Uncertainty[1]
Frequency Accuracy				
25.5 GHz	25.499745 GHz	_____	25.00255 GHz	76,500
Power Level				
Freq. range (GHz)				
25.5	25.499745 GHz	_____	25.00255 GHz	76,500
8722A Full Band	−18 dBm	_____	−12	.3 dB
8722C				
0.05–2.0 GHz	−3.5 dBm	_____	+3.5	.3 dB
2.0–8.0 GHZ	−3.5 dBm	_____	+3.5	.3 dB
8.0–26.5 GHz	−3.5 dBm	_____	+3.5	.3 dB
26.5–40[2] GHz	−8.5 dBm	_____	−1.5	.3 dB

The measurement uncertainty is based on equipment specified in Table 1−3 in the *Service and Overview* section.

Test Description	Minimum		Results	Measurement Uncertainty
Dynamic Range[1]				
Freq. range (GHz)	8722A	8722C		
Forward S21				
0.05 – 2.0	95 dB	107 dB	_____	3 dB
2.0 – 8.0	93 dB	107 dB	_____	3 dB
8.0 – 20	90 dB	102 dB*	_____	3 dB
20 – 40	76 dB	107 dB	_____	3 dB
Dynamic Range				
Freq. range (GHz)	8722A	8722C		
Reverse S21				
0.05 – 2.0	25 dB	82 dB	_____	3 dB
2.0 – 8.0	68 dB	82 dB	_____	3 dB
8.0 – 20	68 dB	80 dB*	_____	3 dB
20 – 40	59 dB	79 dB	_____	3 dB

[1] With HP 85133C flexible cable on test port.

* Valid to 26.5 GHz

TOTAL SYSTEM PERFORMANCE TEST RECORD
HP 8722C OPTION 006

The complete system performance verification record includes the printout from the total system uncertainty test, this test record, and a certificate of calibration.

Use this sheet to record the results of the frequency tests. You may wish to copy this sheet to retain it as a master.

Performance Test Record HP 8722C Option 006 (1 of 3)

Test Facility _____ Report Number _____

_____ Date _____

_____ Date of Last System Calibration _____

_____

Tested by _____ Customer _____

Model _____ Calibration Kit S/N _____ Verification Kit Model _____

Serial Number _____ Test Port Cables _____ Verification Kit S/N _____

Calibration Kit _____ Measurement Calibration Technique _____

Ambient temperature _____ °C Relative Humidity _____

Ambient temperature at measurement calibration _____ °C

Ambient temperature at performance verification _____ °C

Test Equipment Used	Model Number	Trace Number	Cal Due Date
1. Frequency Counter			
2. Verification Kit			
3.			

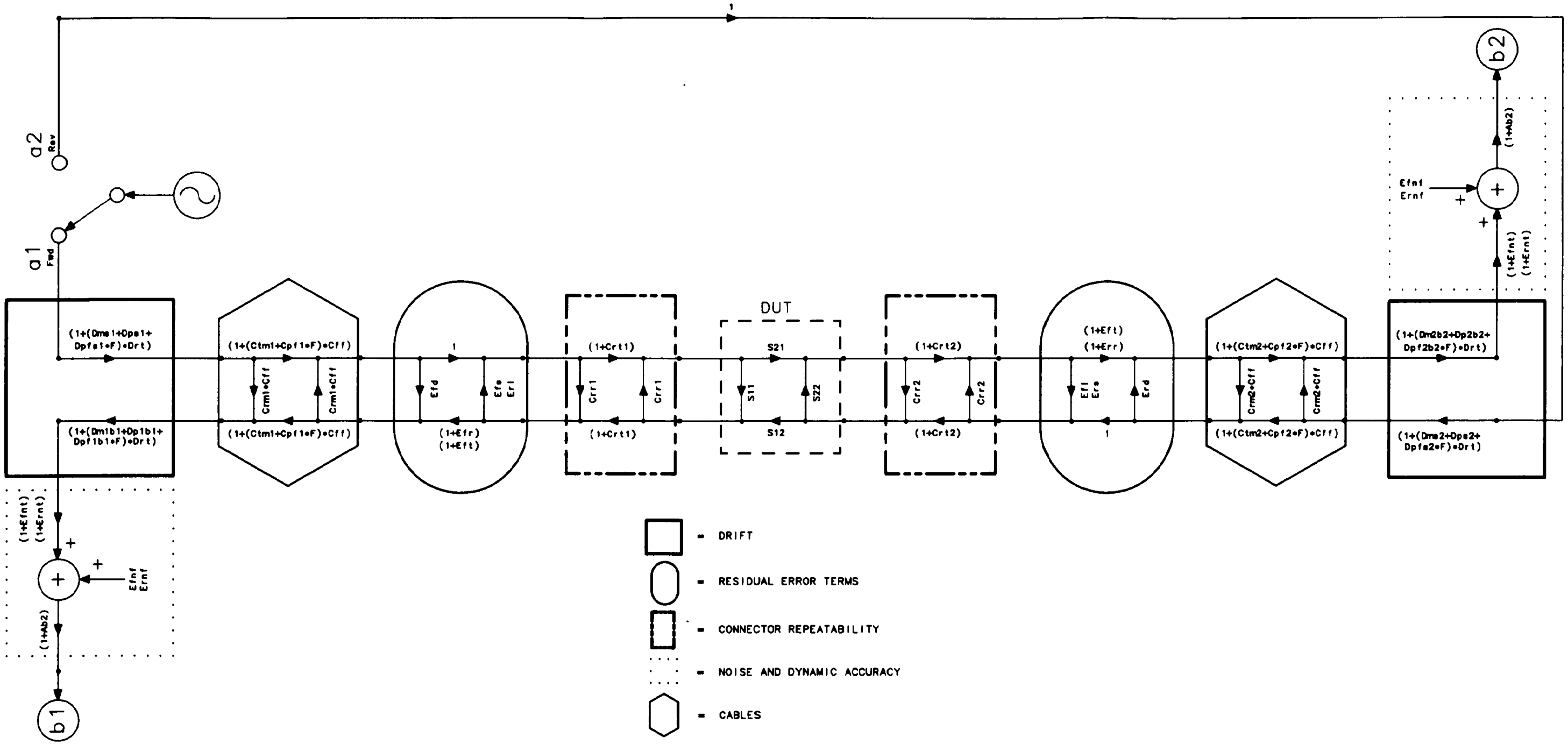
Special Notes: This system verification applies to total measurement uncertainty and frequency accuracy specifications.

Test Description	Minimum	Results	Maximum	Measurement Uncertainty[1]
Frequency Accuracy				
25.5 GHz	25.499745 GHz	_____	25.00255 GHz	76,500
Power Level				
Freq. range (GHz)				
25.5	25.499745 GHz	_____	25.00255 GHz	76,500
8722A Full Band	−18 dBm	_____	−12	.3 dB
8722C				
0.05–2.0 GHz	−3.5 dBm	_____	+3.5	.3 dB
2.0–8.0 GHZ	−3.5 dBm	_____	+3.5	.3 dB
8.0–26.5 GHz	−3.5 dBm	_____	+3.5	.3 dB
26.5–40[2] GHz	−8.5 dBm	_____	−1.5	.3 dB

The measurement uncertainty is based on equipment specified in Table 1−3 in the *Service and Overview* section.

Test Description	Minimum	Results	Measurement Uncertainty
Dynamic Range[1]			
Freq. range (GHz)			
0.05 – 2.0	93 dB	_____	3 dB
2.0 – 8.0	93 dB	_____	3 dB
8.0 – 20	88 dB*	_____	3 dB
20 – 40	82 dB	_____	3 dB

* Valid to 26.5 GHz



ab52c

Figure 4-13. Error Model Flow Chart

Chapter 5. Adjustments

INTRODUCTION

The accuracy of the analyzer is achieved and maintained through mechanical adjustments and correction constants. The correction constants are empirically derived data that are stored in memory and then recalled to refine the instrument's measurements and to define its operation.

Any time the A9 CPU assembly is replaced, all of the correction constants must be regenerated and stored on the new assembly. Alternatively, the data can be retrieved from disk. HP recommends that you store the correction constant data to disk now by referring to the EEPROM backup disk procedure in this section.

ORDER OF ADJUSTMENTS

When performing more than one adjustment, perform them in this order:

Adjustments and Procedures	Page
A9 CC Jumper Position Procedure	5–3
Display Position and Focus Adjustments	5–4
Display Degaussing (Demagnetizing)	5–6
Display Intensity Adjustments	5–7
Serial Number Correction Constant	5–10
Option Numbers Correction Constant	5–11
Analog Bus Correction Constants	5–13
IF Amplifier Correction Constants	5–14
ADC Linearity Correction Constants	5–15
Source Pretune Correction Constants	5–16
EEPROM Backup Disk Procedure	5–17
Reference Assembly VCO Tune Adjustment	5–19
Frequency Accuracy Adjustment	5–21
Sampler Check	5–22
Power Adjustments	5–24
Low Band Power Level Adjustment	5–25
Blanking Adjustment	5–26
Power Linearity Correction Constant	5–27
Cal Kit Defaults Correction Constants	5–28

TEST EQUIPMENT

See the *Table of Service Test Equipment* in the *Service and Equipment Overview.*

INSTRUMENT COVER REMOVAL

See the Adjustments tab. The covers need not be removed for routine maintenance.

A9 CC (CORRECTION CONSTANT) JUMPER POSITION

Move the A9 CC jumper, as explained below, to the ALTER position to change correction constants. The instrument is shipped, and should be operated, with the A9 CC jumper in the NORMAL position.

A9 CC JUMPER POSITION PROCEDURE

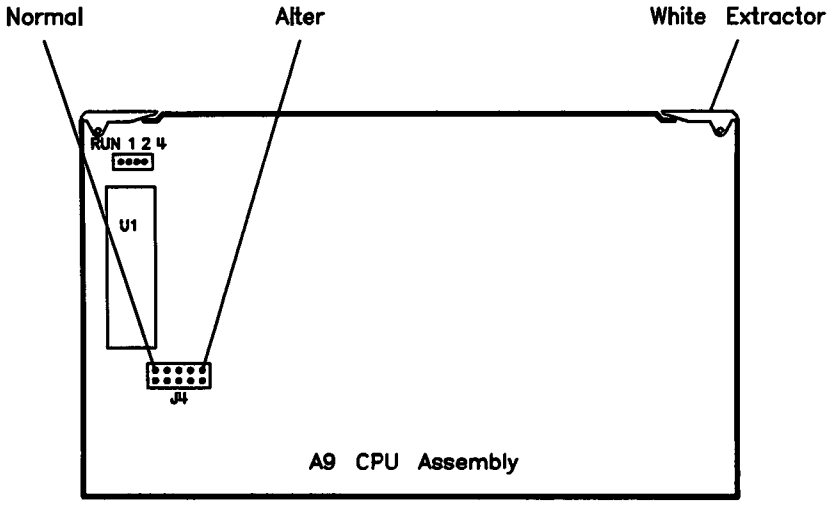


Figure 5–1. A9 CC Jumper Location

CAUTION: Turn off power before removing or installing assemblies.

1. Remove the top cover and PC board stabilizer of the analyzer.
2. The location of the assemblies in the upper portion of the instrument is shown on a label on the under side of the top cover. Remove the A9 CPU assembly and move the A9 CC jumper to the ALTER position (see Figure 5–1).
3. Replace the A9 assembly and run the correction constant routine(s).
4. Return the A9 CC jumper to the NORMAL position when finished.

NOTE: Update the EEPROM backup disk by performing the EEPROM backup disk procedure.

DISPLAY POSITION AND FOCUS ADJUSTMENTS

No display adjustments, other than those in this manual, can be performed in the field (this includes both customers and service centers). Any other adjustments to the display will **void the warranty**. These adjustments are optional as they have been performed at the factory and should rarely require adjustment in the field.

DESCRIPTION AND PROCEDURE

Equipment required: none. Warm−up time: 30 minutes

Vertical Position Adjustment

1. To access vertical and focus adjustments controls, remove the side panel nearest the display.

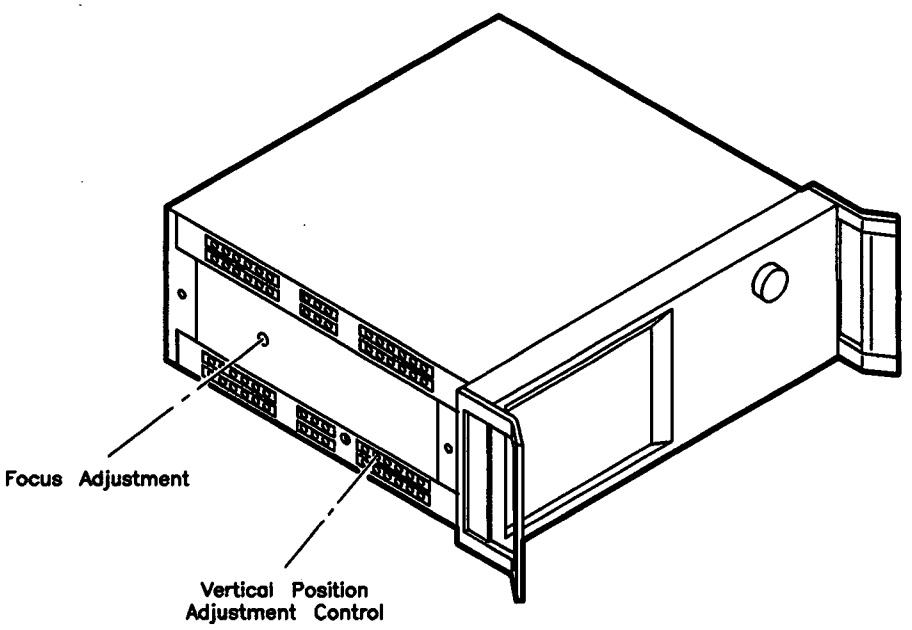


Figure 5−2. Vertical Position Adjustment Control

2. Insert a narrow, preferably non conductive, flat head screw driver (at least 2 inches long) into the vertical position hole.

3. Adjust the control until the softkey labels are aligned with the softkeys

Focus Adjustment

4. Use screwdriver as in step 3 to adjust the focus until display has the most readability.

DISPLAY DEGAUSSING (DEMAGNETIZING)

EQUIPMENT

Any CRT Demagnetizer or Bulk Tape Eraser

DESCRIPTION AND PROCEDURE

Color purity problems may be caused by a magnetized display or by a magnetic field generated external to the instrument. Before attempting to degauss the display, try moving the instrument to a new location to see if this solves the problem.

Should the display become magnetized, or if color purity is a problem, cycle the power several times. Leave the instrument off for at least 15 seconds before turning it on. This will activate the automatic degaussing circuit in the display. If this is insufficient to achieve color purity, a commercially available demagnetizer must be used (either a CRT demagnetizer or a bulk tape eraser can be used). Follow the manufacturer's instructions keeping in mind the following: it is imperative that at first it be placed no closer than 4 inches (10 cm) from the face of the CRT while demagnetizing the display. If this distance is too far to completely demagnetize the CRT, try again at a slightly closer distance until the CRT is demagnetized.

Applying an excessively strong magnetic field to the CRT face can permanently destroy CRT.

Like most displays, the CRT can be sensitive to large magnetic fields generated from unshielded motors. In countries that use 50 Hz, some 10 Hz jitter may be observed. If this problem is observed, remove the device causing the magnetic field.

DISPLAY INTENSITY ADJUSTMENTS

EQUIPMENT

Photometer	Tektronix J16
Photometer Probe	Tektronix J6503
Light Occluder	Tektronix 016–0305–00

DESCRIPTION AND PROCEDURE

There are three display intensity adjustments: background, maximum, and operating default. In general, these adjustments should not be required. However, when either the A19 GSP, A9 CPU, or A18 display assemblies are replaced, perform a visual inspection of the display. If it appears to need adjustment proceed with these adjustments.

NOTE: This procedure should be performed with a photometer and only by qualified service personnel.

Warm–up time: 30 minutes.

Background Adjustment

1. Remove the top cover of the analyzer (refer to the figure on the *Adjustments* tab. Check that the jumper on A9 CPU is in the ALTER position.

2. In a dimly lit room (or with the analyzer CRT shaded from bright lights), press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU (softkey 8) TESTS (softkey 1) [4] [5] [x1].

3. The CRT should display:

   Intensity Cor —ND–

NOTE: The display could be so far out of adjustment that the annotation will be very difficult to read.

4. Press EXECUTE TEST (softkey 1) and YES (softkey 2) at the prompt to alter the correction constants. Alternating vertical bars of three different intensities will be drawn on the CRT. Each bar has a number written below it (either 0, 1, or 2).

5. Adjust the analyzer front panel knob until the vertical bar labeled "1" is just barely visible against the black border. Vertical bar "0" must not be visible.

   With no changes to the analyzer, continue with the next test.

Maximum Intensity Adjustment

This adjustment ensures that the light output at the 100% intensity level is equal to, or less than, 150 NITs. The level is set using a photometer to measure the output light. 100% is the maximum intensity level of light output from the display.

CAUTION

Operating the display at intensities higher than 150 NITs may reduce the life of the display.

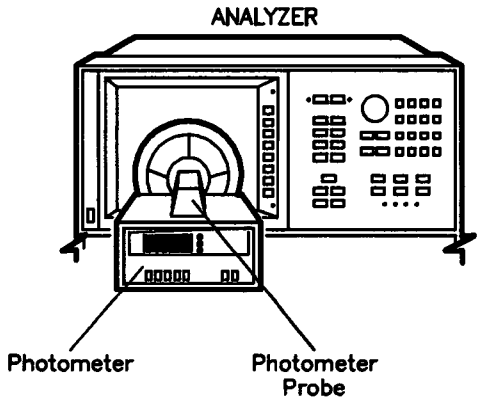


Figure 5–3. Maximum Intensity Adjustment Set–up

6. Press the top softkey.

7. Set the photometer probe to NORMAL. Press [POWER] on the photometer to turn it on and allow 30 minutes warm–up. Zero the photometer according to the manufacturer's instructions. The analyzer CRT should have an all white screen.

8. Center the photometer on the analyzer CRT as shown in Figure 5–3. Adjust the analyzer front panel knob to the maximum (clockwise) position. If the photometer registers greater than 150 NITs *(90), turn the front panel knob until a reading of no more than 150 NITs (90) registers on the photometer. If the photometer registers a reading of less than 150 NITs (90) and greater than 100 (60) NITs, proceed to the next step. If the photometer registers a reading of less than 100 NITs (60), the display is faulty.

***NOTE:** The above intensity levels are read without a display bezel installed. The glass filter transmits 60% of the display light, therefore 150 NITs would be 90 NITs with the bezel installed.

Operating Default Intensity Adjustment

This adjustment sets the default level display intensity. The analyzer normally presets to the same intensity level that was last used. This level is stored in volatile memory. If you power on and off, the memory is lost. Then the analyzer will use the default display intensity to ensure that the display is visible and eliminate concern that the display may not be functioning.

9. Press the top softkey on the analyzer to bring up the next display adjustment mode.

10. Center the photometer on the analyzer CRT as shown in Figure 5–3. Adjust the analyzer front panel knob until the photometer registers 100 NITs of output light if the glass bezel assembly is not installed. Adjust for 60 NITs if the glass bezel is installed.

    This adjustment can be done without the photometer by adjusting the default intensity with the RPG or by keying in a value.

11. Press the top softkey on the analyzer and observe the CRT:

    - "DONE" displayed: the adjustment is done. Refer to the *EEPROM Backup Disk Procedure* to store the new correction constants. This completes the series of three *Display Intensity Adjustments*.
    - "CORRECTION CONSTANTS NOT STORED" displayed: refer to *A9 CC Jumper Position* to reposition jumper; rerun routine.
    - Continued improper operation: refer to *Troubleshooting* to isolate the problem.

SERIAL NUMBER CORRECTION CONSTANT

DESCRIPTION AND PROCEDURE

This procedure customizes the replacement A9 CPU assembly by storing the instrument's unique serial number as a correction constant in EEPROM. Equipment required: none. Warm−up time: 5 minutes.

Perform this procedure ONLY if the A9 CPU assembly has been replaced.

1. Check A9 CC jumper position. Note the ten character serial number on the rear panel identification label.

2. Press [RECALL] RECALL FAC PRESET [DISPLAY] MORE TITLE ERASE TITLE . Rotate the RPG knob to position the arrow below each character of the instrument serial number and press SELECT LETTE to enter each in turn. Enter a total of ten characters: four digits, one letter, and five final digits.Press BACKSPACE or ERASE TITLE to correct errors. When the title is complete and correct, press DONE .

Mistakes cannot be corrected after step 3 is performed.

3. Press [SYSTEM] SERVICE MENU TESTS [4] [9] [x1] . When the display shows "Serial Cor", press EXECUTE TEST . Press YES at the query to alter the correction constant.

4. To check the serial number recognized by the instrument, press [RECALL] RECALL FAC PRESET .

5. If this procedure did not end with "DONE", either the A9 CC jumper was not in the ALTER position or the serial number entered did not conform to the required format or a valid serial number was already stored. In any case, confirm that the A9 CC jumper is in the ALTER position, confirm that the serial number is correct, and repeat this procedure. Contact HP if the procedure still does not end with "DONE".

OPTION NUMBERS CORRECTION CONSTANT

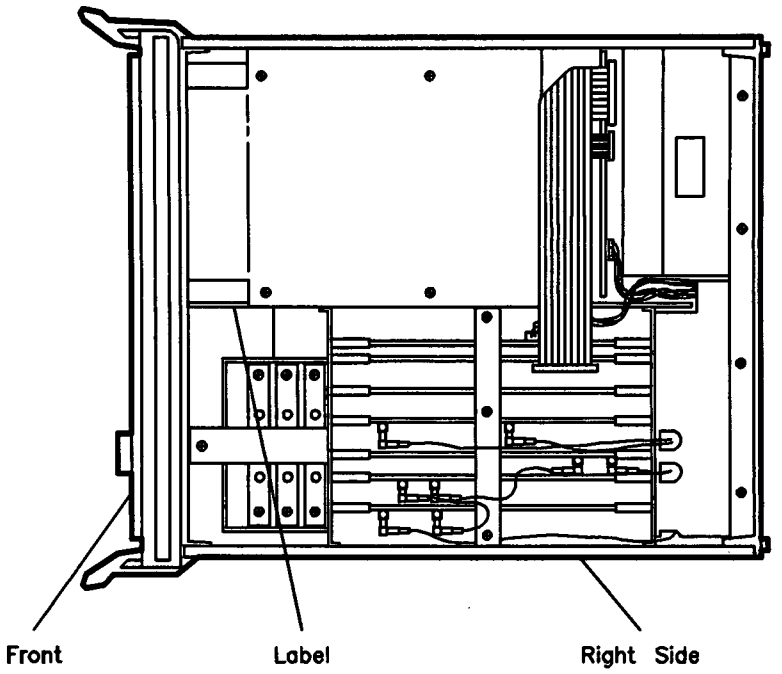


Figure 5–4. Location of Keyword Label

DESCRIPTION AND PROCEDURE

Special information is stored on the A9 CPU assembly of instruments with option 001 (1 Hz resolution) or option 010 (time domain) or Option 003 (extended dynamic range) or any combination. Warm–up time: 5 minutes.

Perform steps 1 through 4 *only* if:

(1) the instrument has option 001 or 010 or both, AND
(2) the A9 CPU assembly has been replaced, AND
(3) the serial number correction constant procedure has been performed.

NOTE: Perform step 5 after steps 1 through 4 (if applicable) to add Option 003 to the A9 CPU EEPROM.

1. Remove the top cover of the instrument. Check the A9 CC jumper position (it must be in the ALTER position). Note the keyword on the keyword label (see Figure 5–4).

2. Press [RECALL] RECALL FAC PRESET [DISPLAY] MORE TITLE ERASE TITLE .Rotate the RPG knob to position the arrow below each character of the keyword, and press SELECT LETTE to enter each in turn. Press BACKSPACE or ERASE TITLE to correct errors. When the title is complete and correct, press DONE .

Mistakes cannot be corrected after step 3 is performed.

3. Press [SYSTEM] SERVICE MENU TESTS [5] [0] [x1] . When the display shows "Option Cor", press EXECUTE TEST. Press YES at the query to alter the correction constant.

4. If this procedure did not end with "DONE", either the A9 CC jumper was not in the ALTER position or the keyword entered did not conform to the required format. In either case, confirm that the A9 CC jumper is in the ALTER position and repeat this procedure. Contact HP if the procedure still does not end with "DONE".

5. To reactivate Option 003, the A9CC jumper must be in the ALTER position. Turn on the analyzer and press [SYSTEM] SERVICE MENU PEEK/POKE PEEK/POKE ADDRESS [1] [3] [1] [4] [6] [0] [8] [x1] POKE [1] (or [−] [1])[x1] .

6. Press [RECALL] RECALL FAC PRESET to verify that the proper options are loaded.

ANALOG BUS CORRECTION CONSTANTS

DESCRIPTION AND PROCEDURE

This procedure calibrates the analog bus by using three reference voltages (ground, +0.37V and +2.5V). It then stores the calibration data as correction constants in EEPROM. Equipment required: none. Warm-up time: 30 minutes.

1. Check A9 CC jumper position. Press [RECALL] **RECALL FAC PRESET** [SYSTEM] **SERVICE MENU** **TESTS** [4] [4] [x1]. When the display shows "ABUS Cor", press **EXECUTE TEST** and then press **YES** at the query to alter the correction constants.

2. If this procedure did not end with "DONE", refer to *Digital Control*.

IF AMPLIFIER CORRECTION CONSTANTS

EQUIPMENT

RF cable ..... HP 85133C/D/E/F

DESCRIPTION AND PROCEDURE

These correction constants compensate for possible discontinuities of dynamic signals greater than −30 dBm. Warm−up time: 30 minutes.

1. Check A9 CC jumper position. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS [4] [7] [x1] and then press EXECUTE TEST when "IF Step Cor" appears. Press YES at the query to alter the correction constants.

2. At the prompt, connect the RF cable (the thru) between ports 1 and 2 and press CONTINUE.

3. If the procedure does not end with "DONE", refer to *Digital Control*.

ADC LINEARITY CORRECTION CONSTANTS

DESCRIPTION AND PROCEDURE

These correction constants improve dynamic accuracy by shifting small signals to the most linear part of the ADC quantizing curve. Warm−up time: 5 minutes.

1. Check A9 CC jumper position. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS [4] [8] [x1]. When the CRT displays "ADC Ofs Cor", press EXECUTE TEST.

2. Press YES at the query to alter the correction constants.

3. If this procedure did not end with "DONE", refer to *Digital Control*.

SOURCE PRETUNE CORRECTION CONSTANTS

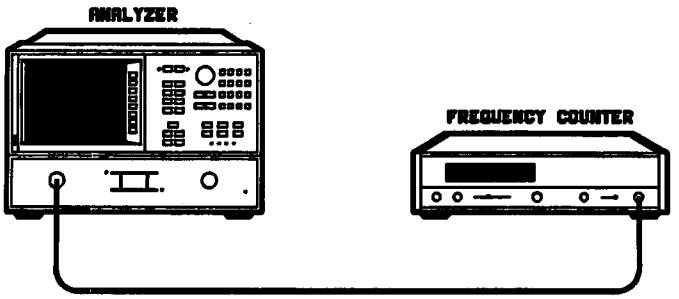


Figure 5–5. Source Pretune Correction Constants Setup

EQUIPMENT

Frequency counter ..... HP 5351B*
RF cable ..... HP 85133C/D/E/F

*The frequency accuracy of the HP 8566A/B spectrum analyzer is sufficient for this procedure.

DESCRIPTION AND PROCEDURE

This adjustment generates a correction constant which pretunes the YIG oscillator to insure proper phase lock. Warm–up time: 30 minutes.

1. Check A9 CC jumper position. Connect the equipment as shown in Figure 5–5 and then press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS ADJUSTMENT TESTS When the CRT displays "Pretune Adj", press EXECUTE TEST. Press YES at the query to alter the correction constants.

2. When the prompt, "Set source to 2.345 GHz, then continue" appears, use the RPG knob to adjust the frequency of the analyzer source to within 5 MHz of 2.345 GHz. The measured frequency will vary with the SRC DAC tune number. Press CONTINUE when the frequency is set.

3. When the prompt, "Set source to 19.550 GHz, then continue" appears, press [2] [k/m] (this sets the SRC DAC to 2000), use the RPG knob to adjust the frequency of the analyzer source to within 5 MHz of 19.550 GHz. Press CONTINUE when the frequency is set.

4. When the CRT displays "DONE", press [RECALL] RECALL FAC PRESET.

5. If any error messages appear, refer to *Source*.

EEPROM BACKUP DISK PROCEDURE

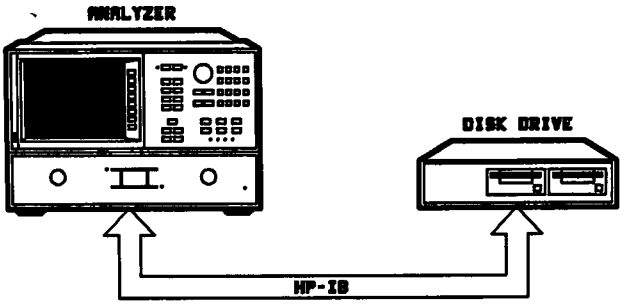


Figure 5–6. EEPROM Backup Procedure Setup

EQUIPMENT

CS80 disk drive	HP 9122S/D
HP–IB cable	HP 10833A/B/C/D
3.5 in microfloppy disk	HP 92192A (box of 10)

DESCRIPTION AND PROCEDURE

Correction constants are stored in EEPROM on the A9 assembly. The great value of the EEPROM backup disk is its capability to store all of the correction constant data to a new or repaired A9 assembly without having to rerun the correction constant procedures.

- Make an EEPROM backup disk and keep it current.
- Store the correction constant data to the EEPROM backup disk each time a correction constant routine is performed.
- Retrieve correction constant data from the EEPROM backup disk if the A9 assembly is replaced.

How to Make an EEPROM Backup Disk and Store Correction Constant Data to It

1. Connect the instruments as shown in Figure 5–6 and turn them on. Make sure the drive is set to HP–IB address 00. Then press [LOCAL] SYSTEM CONTROLLER .
2. If the disk is not initialized, press [SAVE] STORE TO DISK DEFINE, INIT, PURG INITIALIZE DISK INIT DISK? YES.
3. Press [SYSTEM] SERVICE MENU SERVICE MOD MORE STORE EEPR 0*to store the EEPROM data with the instrument state.*

4. Press [SAVE] STORE TO DISK TITLE FILES TITLE FILEn ERASE TITLE and then use the RPG and softkeys to title the file "N12345" (the first character must be a letter; 12345 represent the last five digits of the instrument's serial number).

   When finished, press DONE RETURN STORE N12345.

5. Label the disk with the serial number of the instrument and the words "EEPROM Backup Disk."

How to Retrieve Correction Constant Data from the EEPROM Backup Disk

1. Connect the instruments as shown in Figure 5–6. Make sure the drive is set to HP–IB address 00.

2. Make sure the A9 CC jumper is in the ALTER position. Install the new A9 assembly.

3. Turn on the instruments. If the analyzer display is dark, press [DISPLAY] MORE (bottom softkey) ADJUST DISPLAY (fourth softkey from the top) INTENSITY (top softkey) and then turn the RPG knob.

NOTE: Disregard noisy trace data or error messages on the display now.

4. Press [LOCAL] SYSTEM CONTROLLER [RECALL] LOAD FROM DISK READ FILE TITLES LOAD N12345 where N12345 represents the file name of the EEPROM data for the analyzer. "FILE 1" is the filename of the EEPROM data disk supplied.

5. Perform the serial number and, if applicable, the option number correction constant routines.

6. Press [RECALL] RECALL FAC PRESET and verify that good data was transferred to EEPROM by performing a simple measurement.

7. In case of difficulty, refer to *Troubleshooting*.

REFERENCE ASSEMBLY VCO TUNE ADJUSTMENT

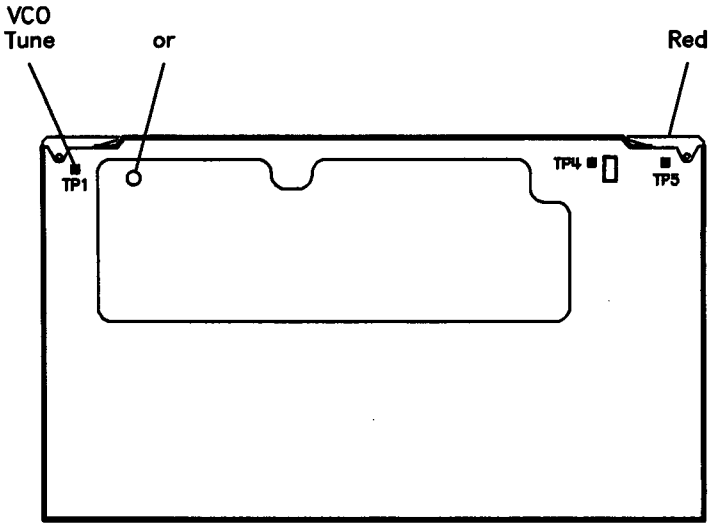


Figure 5–7. VCO Tune Adjustment Location

EQUIPMENT

Extender board, large ..... part of tool kit HP p/n 08720–60004

DESCRIPTION AND PROCEDURE

This adjustment centers the reference assembly VCO (voltage controlled oscillator) in its tuning range. Warm–up time: 30 minutes.

1. Remove the instrument top cover. If VCO TUNE on the A12 assembly (red extractors) is accessible, continue with step 2. See Figure 5–7. Otherwise, install the A12 assembly on the extender. Use SMB cables as required (the EXT REF cable need not be reconnected now).

2. Press [RECALL] RECALL FAC PRESET [MENU] CW FREQ SWEEP TIME [MANUAL] [2] [x1] [SYSTEM] SERVICE MENU INPUT PORT ANALOG BUS IF [1] [5] [x1] to display "VCO Tune."

3. Press [MKR] and [SCALE REF] SCALE / DIV [.] [5] [x1].

4. Adjust VCO TUNE with a non–metallic adjustment tool to 0.0V ±500 mV (within one division of the reference line). The adjustment is sensitive, and if out of adjustment may display an irregular waveform. Slowly tune through the entire adjustment range to obtain a flat trace, then carefully tune for 0.0V. Once the adjustment is done, it should be rechecked with the reference board reinstalled in the instrument, and at operating temperature.

5. If VCO TUNE cannot be adjusted as specified, and the instrument passes the Abus test, the A12 assembly must be replaced.

FREQUENCY ACCURACY ADJUSTMENT

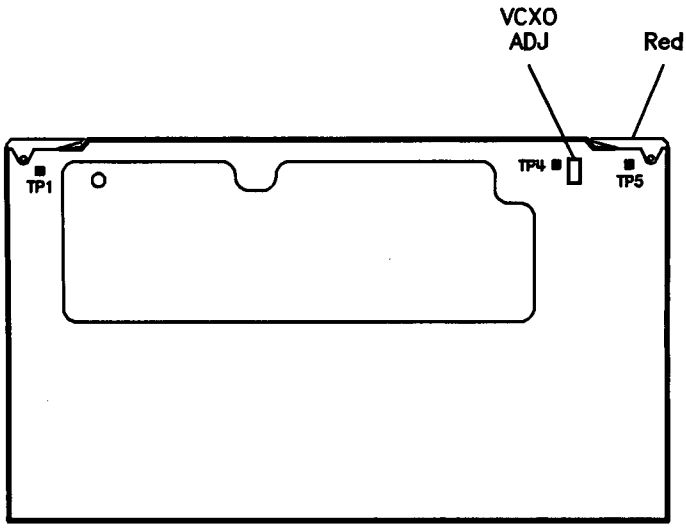


Figure 5–8. VCXO Adjustment Location

EQUIPMENT

Frequency counter	HP 5351B
RF cable	HP 85133C/D

DESCRIPTION AND PROCEDURE

This adjustment sets the VCXO (voltage controlled crystal oscillator) frequency to maintain the instrument's frequency accuracy. Warm–up time: 30 minutes.

1. Connect port 1 of the analyzer to the frequency counter input (see Figure 5–5). Press [RECALL] [RECALL FAC PRESET] [MENU] [CW FREQ] [2] [0] [.] [0] [G/n] .
2. If the measured frequency is 20.0 GHz ±200 kHz (19.999800–20.000200 GHz), no adjustment is necessary, although the instrument can easily be adjusted much closer.
3. Otherwise, locate the A12 assembly (red extractors) and adjust VCXO ADJ (see Figure 5–8) for a frequency counter reading as close to 20.0 GHz as possible.
4. If you are unable to adjust the frequency as specified, replace the A12 assembly.

SAMPLER CHECK

EQUIPMENT

RF cable	HP 85133C/D
2.4 mm (f) 50 ohm termination (2)	HP 85138B*

*or use one female termination (00901-60004) and one male termination (00901-60003) with an f/f adapter (85056-60006), all part of HP 85056B Calibration Kit.

DESCRIPTION AND PROCEDURE

Samplers are adjustable only at the factory. New samplers which do not pass the following check must be replaced. Warm-up time: 30 minutes.

NOTE: Make sure all connections are good before checking a sampler or concluding it is faulty.

1. Connect the RF cable from port 1 to port 2. Turn on the instrument and press [RECALL] RECALL FAC PRESET [START] [3] [G/n] [MKR FCTN] TRACKING ON SEARCH: MIN. Perform step 2, 3 or 4 to check the A, B or R sampler.

A Sampler Check

2. a. To check the A sampler (A65, at port 1) press [MEAS] Trans: REV S12. The minimum marker reading should be >-7 dB (within 7 dB of the 0 dB reference line).

   b. Press [START] [5] [0] [M/u] [AVG] IF BW [1] [0] [0] [x1] to set the start frequency and bandwidth. Remove the RF cable and connect a 50 ohm termination at each port. Press [SCALE REF] [2] [0] [x1] REFERENCE VALUE [-] [7] [0] [x1] to rescale the CRT.

   c. Press [MKR FCTN] TRACKING ONSEARCH: MAX. After 32 sweeps have been averaged, the maximum marker reading should be <-70 dB.

   d. If the readings in steps 2a or 2c are not as specified, replace A65.

B Sampler Check

3. a. To check the B sampler (A66, at port 2) press [MEAS] Trans: FWD S21. The minimum marker reading should be >-7 dB.

   b. Press [START] [5] [0] [M/u] [AVG] IF BW [1] [0] [0] [x1] to set the start frequency and bandwidth. Remove the RF cable and connect a 50 ohm termination at each port. Press [SCALE REF] [2] [0] [x1] REFERENCE VALUE [-] [7] [0] [x1] to rescale the CRT.

c. Press MKR FCTN MKR SEARCH SEARCH: MAX. After 32 sweeps have been averaged, the maximum marker reading should be <-70 dB (below the reference line).

d. If the readings in steps 3a or 3c are not as specified, replace A66.

R Sampler Check

4. To check the R sampler (A64, internal) perform steps 2a and 3a (the first part of the A sampler and B sampler check). If both readings are not as specified, replace A64.

POWER ADJUSTMENTS

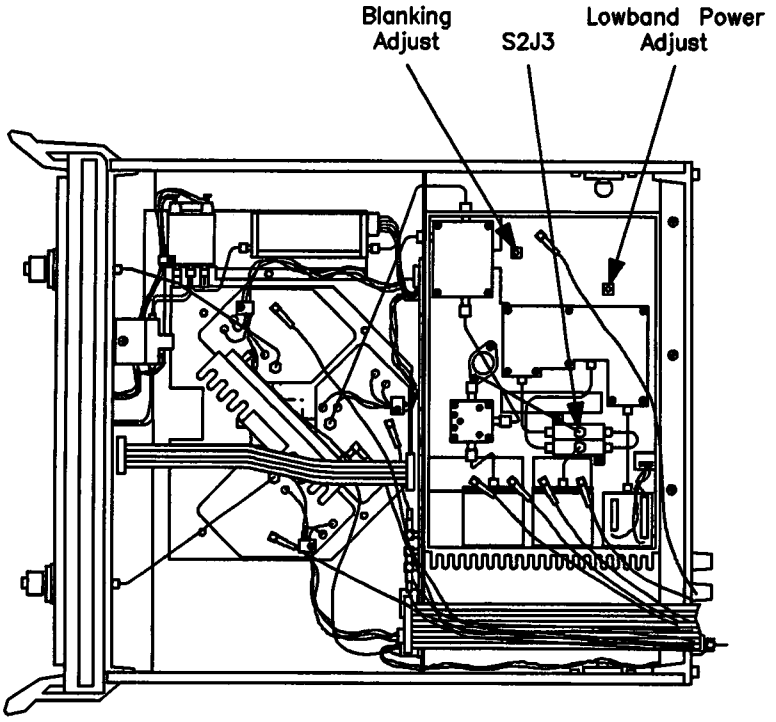


Figure 5–9. Low Band Power Adjustment

EQUIPMENT

Power meter	HP 436A, HP 437A/B or 438A
Power sensor	HP 8487A
2.4 mm (f)/(f) adapter	85056–60006 (part of HP 85056B calibration kit)
Frequency counter	HP 5351B
SMA flexible cable	8120–4396
2.4 mm (f) – 3.5 mm (m) adapter	HP 11901D

LOW BAND POWER LEVEL ADJUSTMENT

DESCRIPTION AND PROCEDURE

This adjustment sets the lowband power into the M/D/S (8722C, M/A/D/S) microcircuit to 0 dBm. Warmup time: 30 minutes.

1. Remove the covers and fasteners so that the analyzer can be pivoted open (see the *Adjustments and Correction Constants* tab). Remove the source cover

NOTE: Reconnect the cables that were disconnected to remove the source cover.

2. Remove the cable between S1 and the M/D/S (8722C, M/A/D/S) and reconnect it to S1 so it will be possible to connect a counter to the other end of the cable.

3. Turn on the instrument (ignore phase lock error messages) and press [RECALL] **RECALL FAC PRESET** [SYSTEM] **SERVICE MENU** **SERVICE MOD** **SRC TUNE** **DAC NUM LOW BAN** and adjust the RPG to obtain 50 MHz on the counter (approximately 3650).

4. Calibrate the power meter. Remove the frequency counter and connect the power sensor to the same point. Adjust the low band power level (see Figure 5–10) so that the power meter displays 0 dBm.

NOTE: If you are unable to perform this adjustment refer to the *Source* section of *Troubleshooting* in this manual.

BLANKING ADJUSTMENT

DESCRIPTION AND PROCEDURE

This adjustment sets power level out during retrace. If incorrectly adjusted, the first data points in a sweep may not be stable.

1. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS [5] [4] [x1].
   When the CRT displays "BLANKING ADJ", press EXECUTE TEST.

2. Calibrate the power meter and connect it to port 1 (see Figure 5–10).

3. Use the blanking adjustment to obtain: (HP 8722A, –27 dBm),
   (HP 8722C Opt. 006, –27 dBm), (HP 8722C, -22 dBm) at port 1 (see Figure 5–9).

4. Press continue.

NOTE: If you are unable to perform this adjustment refer to the *Source* section of *Troubleshooting* in this manual.

POWER LINEARITY CORRECTION CONSTANTS

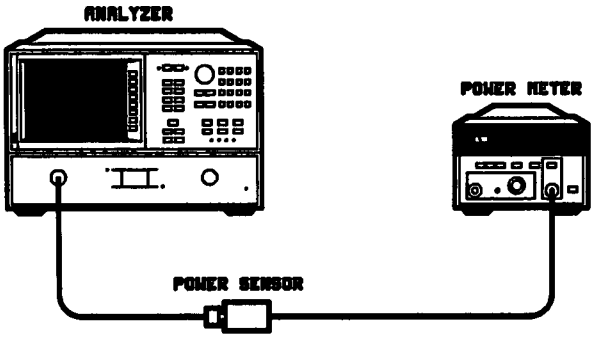


Figure 5–10. Power Linearity Correction Constants

DESCRIPTION AND PROCEDURES

These correction constants improve test port raw power linearity, and set power accuracy.

1. Move the A9 correction constant jumper to the alter position (see the *Adjustments* tab).

2. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS [5] [2] [x1]. When the CRT displays "Power Adj." press EXECUTE TEST. Press YES in response to the instrument prompt `"Caution: OK to alter correction constants?"`

3. Calibrate the power meter and connect it to port 1.

4. Adjust the front panel RPG to obtain −25 dBm (8722C, −20 dBm) at the port, then press CONTINUE.

5. Adjust the front panel RPG to obtain −15 dBm (8722C, −10 dBm) at the port, then press CONTINUE.

6. Adjust the front panel RPG to obtain −10 dBm (8722C, 0 dBm) at the port, then press CONTINUE.

7. If the procedure did not end with `done`, refer to *Digital Control*.

CAL KIT DEFAULTS CORRECTION CONSTANTS

DESCRIPTION AND PROCEDURE

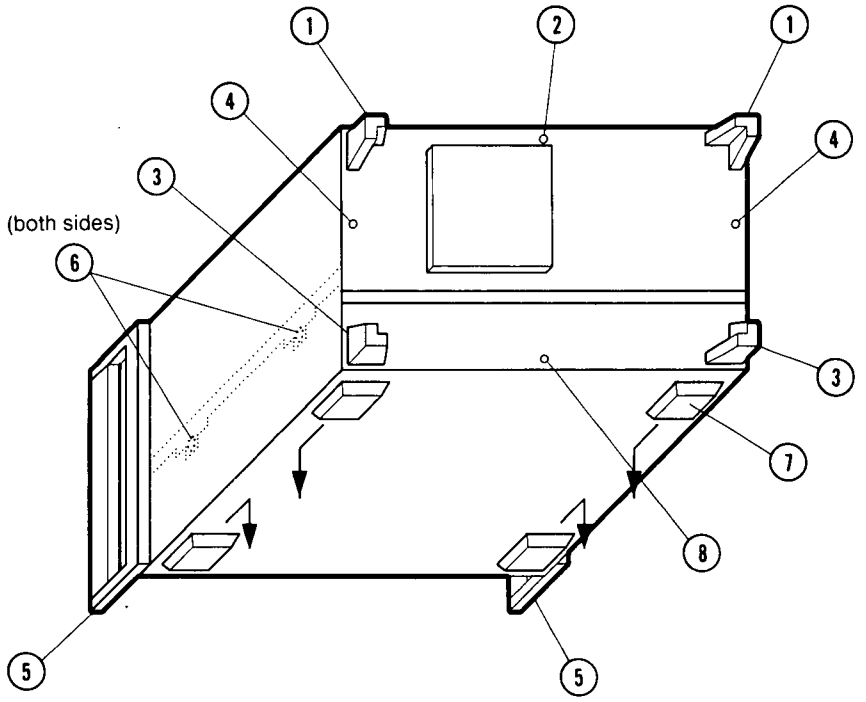
This procedure loads the default calibration kit definitions from ROM into EEPROM. These mathematical device models match the characteristics of the HP 85056BD 2.4 mm, HP 85052B/D 3.5 mm, 85050B/D 7 mm, and 85054B/D type−N calibration kits. They must be stored in EEPROM for error correction to work properly in measurement calibrations with these kits. Equipment required:none. Warm−up time: 5 minutes.

Perform this procedure only if the A9 CPU has been replaced.

1. Check A9 CC jumper position. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU TESTS [5] [1] [x1]. When the display shows "Cal Kit Def," press EXECUTE TEST. Then press YES at the query to alter the correction constants.

2. If this procedure did not end with "DONE," refer to *Digital Control*.

Cover Removal



To remove top cover:
- remove upper rear feet (1)
- loosen screw (2)
- slide cover off

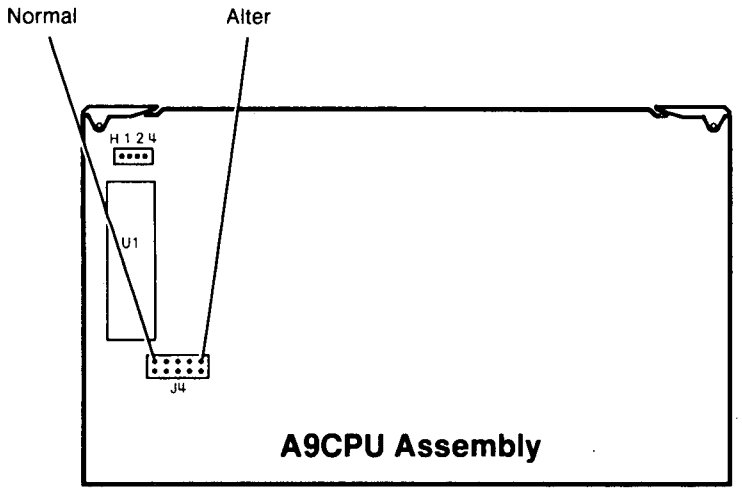
To remove left side cover:
- remove top cover
- remove lower rear foot (3)
- remove screws (4) and handle (5)
- loosen screw (6)
- slide cover back

To remove right side cover:
- remove top cover
- remove lower rear foot (7)
- loosen screw (8)
- slide back cover

To remove bottom cover:
- remove bottom feet (9)
- remove lower rear feet (3) (7)
- loosen screw (10)
- slide cover off

A9 CC jumper position diagram on reverse side.

A9CC Jumper Position



Cover removal diagram on reverse side.

Chapter 6. Troubleshooting (and Block Diagram)

INTRODUCTION

The troubleshooting strategy of the HP 8722 is based on a verification (rather than symptomatic) approach. The first step is to verify the operation of the network analyzer independent of system peripherals. This section, *Troubleshooting*, takes that step and also suggests how to remedy system problems external to the analyzer.

The analyzer overall block diagram is at the end of this section.

The next section, *Isolate Faulty Group*, assumes that the fault is within one of the instrument's five functional groups: power supply, digital control, source, receiver and accessories. *IFG* identifies the group and refers the technician to the appropriate section. These first sections, *Troubleshooting* and *Isolate Faulty Group*, stress simple, straight forward procedures.

Each of the five sections following *IFG* verifies, one at a time, the assemblies within a group until the faulty assembly is identified. These five sections employ more lengthy, complicated procedures.

INITIAL OBSERVATIONS

A system failure can be caused by a problem in the network analyzer and its accessories (cables, calibration and verification kits) or outside the network analyzer, in HP-IB related components (peripheral devices, an external controller, programming). If the failure is obviously in the analyzer or its accessories, go directly to the *Isolate Faulty Group* section. Otherwise disconnect all of the peripheral HP-IB and RF cables from the analyzer.

Turn on the network analyzer and watch for the following in this order:

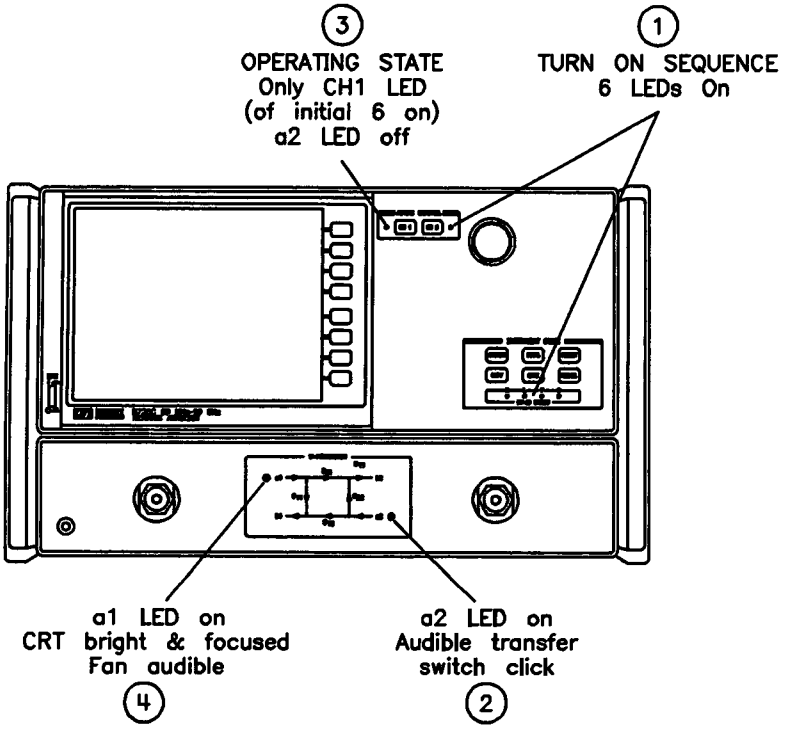


Figure 6–1. Turn On Sequence

In case of unexpected results, check AC line power to the instrument. Check the fuse (rating listed on rear panel, spare inside holder). Check the line voltage setting (use small screwdriver to change).

Refer to *Isolate Faulty Group* if the problem persists and the analyzer does NOT use HP–IB.

TROUBLESHOOTING HP–IB SYSTEMS

Check the network analyzer's HP–IB functions with a known working passive peripheral (like a plotter or printer or disk). Connect the peripheral via a good HP–IB cable to the analyzer. Press [LOCAL] SYSTEM CONTROLLER to enable the analyzer to control the peripheral. Then press SET ADDRESSES and the softkeys to see the device addresses recognized by the analyzer. The factory default addresses are:

Device	HP–IB Address
analyzer	16
Plotter	5
Printer	1
Disk (drive)	0
Controller	21

Other addresses may be used with two provisions: (1) each device must have its own address and (2) the address set on each device must match the one recognized by the analyzer (and displayed on the CRT). Peripheral addresses are often set with a rear panel switch. Refer to the manual of the peripheral to read or change its address.

If Using a Plotter or Printer Make sure it has power, pens, paper, pinch wheels down, and so forth. Plotters should not be in VIEW mode; some plotters need to have P1 and P2 positions set. Press [COPY] and then PLOT or PRINT.

If the result is a copy of the CRT display, HP–IB is functional in the analyzer. Continue with *Troubleshooting Systems with Multiple Peripherals*, *Troubleshooting Systems with Controllers*, or the *Isolate Faulty Group* section.

If the result is not a copy of the CRT display, suspect HP–IB problems in the analyzer: refer to the *Digital Control* section.

If Using a Disk Drive Make sure the drive has power, an initialized disk in the *correct* drive, and the proper disk unit number and volume number (press [LOCAL] to see; default is 0, 0.) With hard disk (Winchester) drives, make sure the configuration switch is properly set (see drive manual).

Press [START] [2] [G/n] [SAVE] STORE TO DISK STORE FILE 1. Then press [PRESET] [RECALL] LOAD FROM DISK LOAD FILE 1. If the resultant trace starts at 2 GHz, HP–IB is functional in the analyzer. Continue with *Troubleshooting Systems with Multiple Peripherals*, *Troubleshooting Systems with Controllers*, or the *Isolate Faulty Group* section.

If the resultant trace does not start at 2 GHz, suspect HP–IB problems in the analyzer: refer to the *Digital Control* section.

Troubleshooting Systems with Multiple Peripherals

Connect any other system peripherals (but not a controller) one at a time and check their functionality. Any problems observed are in the peripherals or HP–IB cables, or are HP–IB address problems (see above).

Troubleshooting Systems with Controllers

Passing the preceding checks indicates that the HP–IB functions are normal in the analyzer. Therefore, if the analyzer has not been operating properly with an external controller, suspect the controller. Check the following:

- HP–IB interface hardware must be installed, see *BASIC User's Manual*.
- Select code, see *BASIC User's Manual*.
- I/O and HP–IB binaries loaded, see *BASIC User's Manual*.
- Compatibility, must be HP 9000 series 200/300, see *System Overview*.
- Programming syntax, see the *HP–IB Programming Guide*.

If the analyzer appears to be operating unexpectedly but has not completely failed, go to the *Isolate Faulty Group* section.

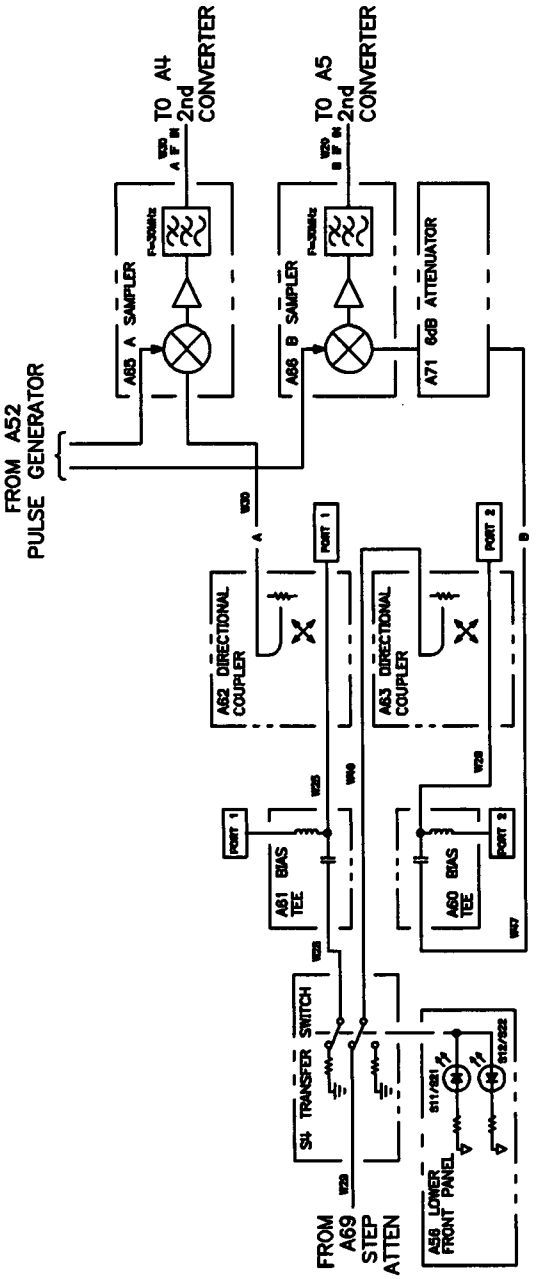
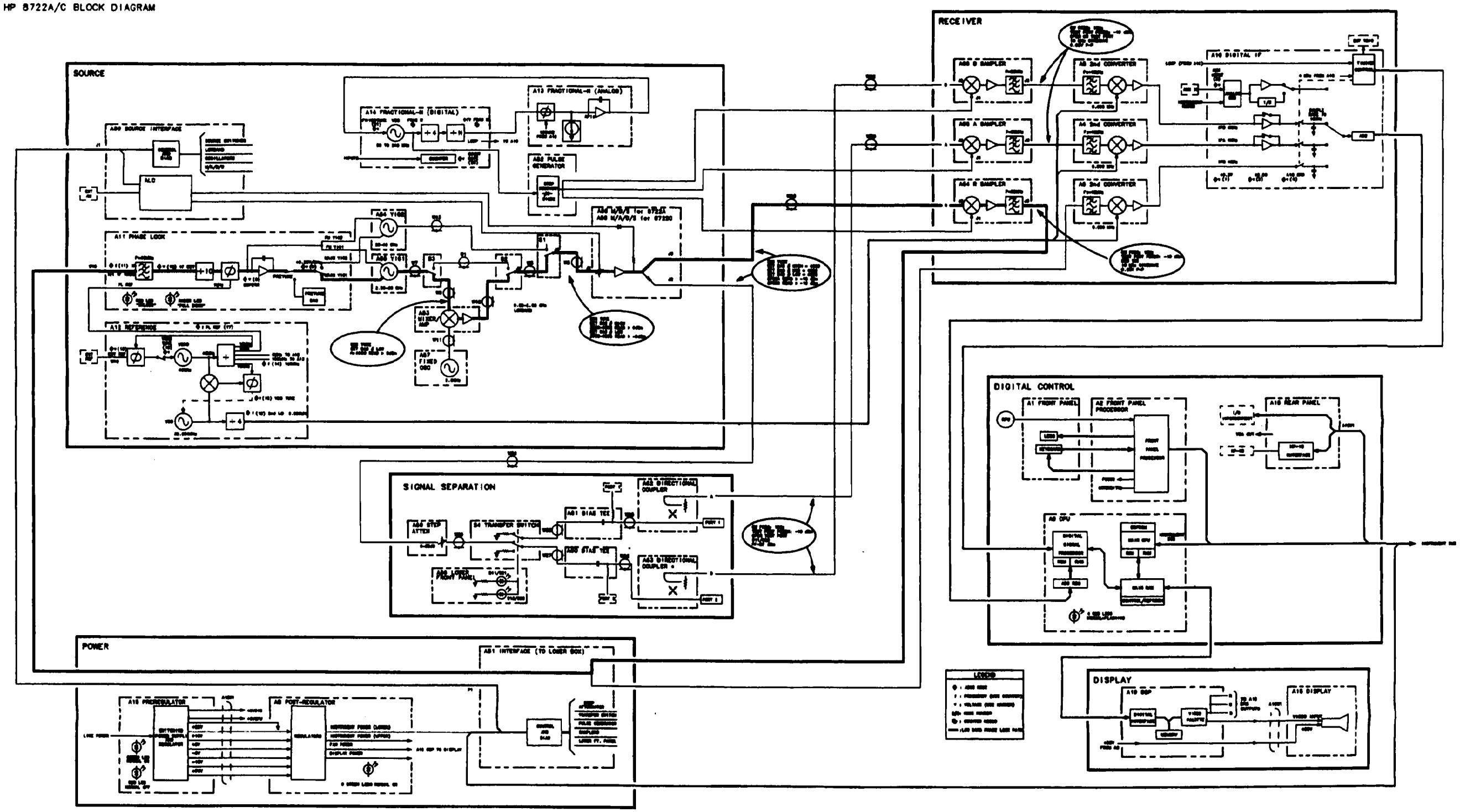


Figure 6−3. Option 003 Partial Block Diagram

HP 8722A/C BLOCK DIAGRAM



ISOLATE FAULTY GROUP

Chapter 7. Isolate Faulty Group

INTRODUCTION

The purpose of this section is to determine which major group of assemblies in the instrument is faulty. The premise of the following troubleshooting sections is that each successive group depends on the proper functioning of previous groups to work. For example, each functional group depends on the power supply group. Hence the power supply group is examined first. Similarly, for the receiver portion of the instrument to function, the source assemblies must be operating properly. Troubleshoot the functional groups and the assemblies in the order presented.

The checks that isolate the faulty functional group are reproduced twice: first in a longer, tutorial format and then in a brief checklist format. The main points in both formats are numbered the same for easy cross reference. Either format can be used to start troubleshooting the instrument on location or over the phone. Both formats conclude with a reference to Table 7−1, the *Functional Group Assemblies and Equipment* table which lists, by functional group, all of the assemblies and the associated service equipment.

POWER SUPPLY

Turn on the instrument.

1. Check to see that the fan is operating properly, fan speed varies, depending on instrument temperature.

2. Check the rear panel (A15) LEDs: the green LED should be on; the red LED should be off.

3. Check the A8 post−regulator LEDs: remove the instrument top cover; all of the green LEDs should be on. Look for 9 LEDs.

If the above checks yield unexpected results:

a. Refer to Table 7−1, at the end of this section to see the associated assemblies and required equipment.

b. Go to the *Power Supply* troubleshooting section to continue troubleshooting.

If the above checks indicate normal instrument operation, proceed with the next paragraph.

DIGITAL CONTROL

Store the factory preset in Preset REG 5, by pressing [RECALL] RECALL FAC PRESET [SAVE] SAVE PRESET 5 .

Cycle power.

4. All six upper front panel LEDs and the a2 lower front panel LED should turn on, and then you should hear an audible click and see the a2 LED turn off, the a1 LED turn on, and all upper front panel LEDs except CH 1 turn off.

NOTE: Magnetic fields will cause distortion of the color display. Typical sources of magnetic fields are magnetized work benches, electric motors, power supplies, etc. Should you experience distortion, move the analyzer to a different location. If the problem does not go away, perform the display degaussing routine in chapter 5.

5. The display should be bright and focused.

6. Press [SYSTEM] SERVICE MENU TESTS [1] [x1] to verify that the PRESET tests passed.

7. Press [0] [x1] EXECUTE TEST to run ALL INT test.

8. Press [1] [9] [x1] EXECUTE TEST to run the ABUS test and check to see that the test passes.

   If the above checks yield unexpected results or any test fails:

   a. Refer to Table 7−1, at the end of this section to see the associated assemblies and required equipment.

   b. Go to the *Digital Control* troubleshooting section to continue troubleshooting.

Otherwise, proceed with the next paragraph.

SOURCE

9. Check the display to make sure there are no phase lock error messages. If messages are present:

   a. Refer to Table 7−1, at the end of this section to see the associated assemblies and required equipment.

   b. Go to the *Source* troubleshooting section to continue troubleshooting.

10. Connect a power sensor to port 1. Press [MENU] POWER [−] [1] [5] [x1] RETURN CW FREQ to check power at 1 GHz, and then press [↑] repeatedly to check power at 2, 5, 10, 20 and 40 GHz. The power should be between −18 dBm and −12 dBm. Press [MEAS] S22 and connect the power sensor to port 2. Repeat the measurement from port 2. If the power is not within specification at either port:

a. Refer to Table 7−1, at the end of this section to see the associated assemblies and required equipment.

b. Go to the *Source* troubleshooting section to continue troubleshooting.

Otherwise, continue with the next paragraph.

RECEIVER

If any input shows unexpected results, refer to Table 7−1 for the associated assemblies and equipment required. Then go to the *Receiver* troubleshooting section. Otherwise, proceed to *Accessories*.

11. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU INPUT PORTS R. The trace should show a relatively flat line at about —20 ±5 dB.

12. Connect an open or short to port 1. Press A to look at input A (port 1). The trace should resemble Figure 7−1 below, with a minimum of about —50 dB at 50 MHz and a value around —30 dB over the flat section.

13. To check input B (port 2), connect an open or short to port 2, then press B TEST SET REV to drive port 2. Again, the trace should be about 6 dB lower.

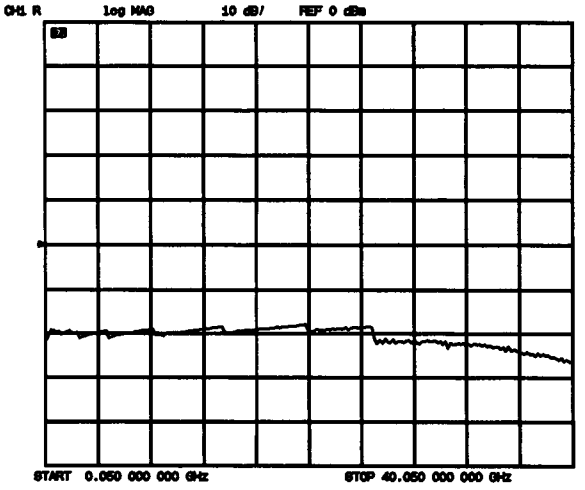


Figure 7−1. Typical Trace

ACCESSORIES

If the instrument has passed all of the above checks but is still making incorrect measurements, probably either the cables or the calibration kit devices are faulty. Only the analyzer and the suspect cable or calibration kit devices are required to troubleshoot such problems. Turn to the *Accessories* troubleshooting section.

Table 7–1. Functional Group Assemblies and Required Equipment

Functional Group	Assemblies Included	Required Equipment			
		DVM	Power Meter	Freq. Counter	Scope
Power Supplies	A8 Post–Regulator A15 Preregulator	●			
Digital Control	A1 Front Panel A2 Front Panel Interface A9 CPU A10 Digital IF A16 Rear Panel A18 Display A19 GSP A51 Interface	●		●	●
Source	A11 Phaselock A12 Reference A13 Fractional–N Analog A14 Fractional–N Digital A52 Pulse Generator A53 Low Band Microcircuit A55 YIG 1 A54 YIG 2 A57 Cavity Oscillator A58 M/D/S Microcircuit A59 Source Interface Board A60/61 Bias Tee A64 Sampler A68 6 dB Attenuator S1, 2, 3, 4 Microwave Switch	●	●	●	●
Receiver	A4/5/6 Second Converter A10 Digital IF A62/63 Coupler A64/65/66 Sampler	●		●	●
Accessories	—				

ISOLATE FAULTY GROUP WORKSHEET (1 of 2)

(Photocopy for multiple use.)

User _____ Date _____

Serial Number _____ Firmware Revision _____ Phone _____

COMPLAINT _____

_____

_____

POWER SUPPLY Turn instrument on.	**YES** (Normal)	**NO** (Abnormal)
1. Fan operating?	☐	☐
2. Rear panel: green LED on? red LED off?	☐	☐
3. All A8 green LEDs on?	☐	☐

If any "NO" boxes are checked, see Table 7–1, then *Power Supply* section.

DIGITAL CONTROL **Cycle power.**		
4. Do all six upper front panel LEDs turn on, then five off?	☐	☐
Audible click, a1/a2 LEDs toggle?	☐	☐
5. CRT bright and focused?	☐	☐
6. Press [SYSTEM] SERVICE MENU TESTS [1] [x1] EXECUTE TEST. PRESET pass?	☐	☐
7. Press [0] [x1] EXECUTE TEST. ALL INT tests pass?	☐	☐
8. Press [1] [9] [x1] EXECUTE TEST. ABUS pass?	☐	☐

If any "NO" boxes are checked, see Table 7–1, then *Digital Control*.

SOURCE **Press [RECALL] RECALL FAC PRESET.**

9. Does the instrument phase lock (is the display free of phase lock error messages)?	☐	☐
If "NO", see Table 7–1, then Source.		
10. Does the CW power at the output port measure −15 dBm ± 3 dB? (Option 003: Port 1 only)	☐	☐
If "NO", see Table 7–1, then *Source*.		

ISOLATE FAULTY GROUP WORKSHEET (2 of 2)

(Photocopy for multiple use.)

RECEIVER	YES (Normal)	NO (Abnormal)
11. Press [SYSTEM] SERVICE MENU INPUT PORTS R. Does the display show a flat trace at —20 dBm?	☐	☐
12. Connect an open or short to port 1. Press A. Does the display show a trace similar to Figure 7–1?	☐	☐
13. Move the open or short to port 2. Press B TEST SET REV Does the display show a trace similar to Figure 7–1?	☐	☐

If any "NO" boxes are checked, see Table 7–1, then Receiver.

ACCESSORIES

If the instrument has passed all of the above tests (all "YES" boxes checked) but is still making incorrect measurements, the problem is most likely with the cables or calibration kit devices. Refer to the Accessories section.

SOLUTION _____

_____

_____

_____

NOTE: Following assembly replacement, refer to the *Related Service Procedures* table in the *Post–Repair Procedures* section. The table specifies accessory adjustment and verification procedures following assembly replacement.

Adjustments Performed	Verifications Performed
_____	_____
_____	_____
_____	_____

POWER SUPPLY

Chapter 8. Power Supply

INTRODUCTION

Either the A15 red LED is not OFF or one or more of the A8 green LEDs is not ON (as determined in a previous section, *Troubleshooting*). This abnormal situation may mean the A15 preregulator or A8 post–regulator is not functioning properly, but faults elsewhere in the instrument can also affect these power supply assemblies. So the suggested troubleshooting sequence is to check:

- Fan and power supply error messages (see *Start Here*)
- A15 preregulator and loads
- A8 post–regulator and loads

LED State Definitions

Within this section, LEDs are described as being in only two states:

- **ON.** Bright and steady, normal green LED state, abnormal red LED state.
- **OFF.** No light at all, abnormal green LED state, normal red LED state.

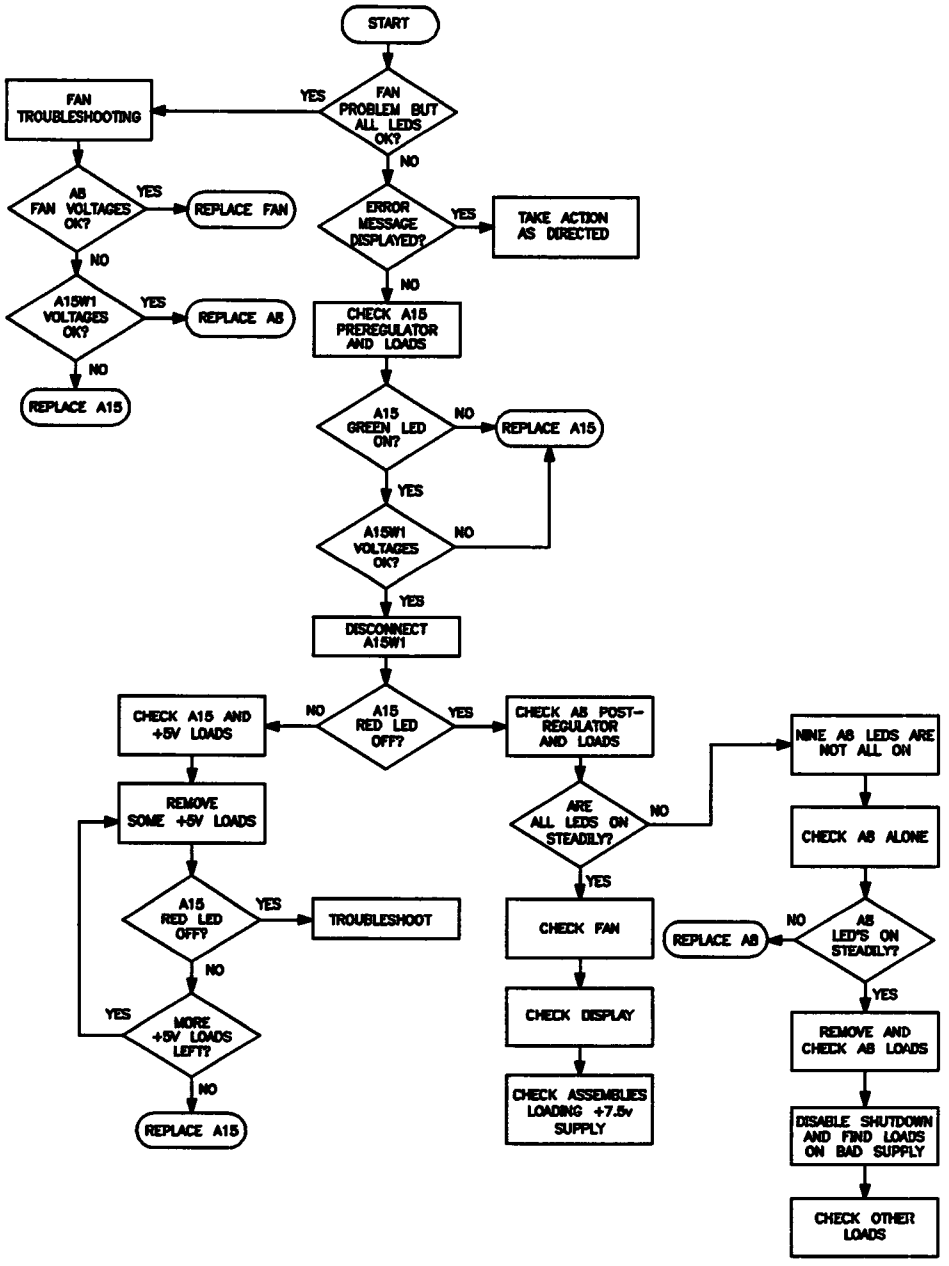
NOTE: Flashing LEDs on A8 indicate that the shutdown circuitry on the A8 post–regulator is protecting power supplies from overcurrent conditions by repeatedly shutting them down. This may be caused by supply loading on A8 or on any other assembly in the instrument. For troubleshooting, treat flashing LEDs as if they are in the "OFF" state.

WARNING

Hazards are involved in power supply troubleshooting. It should be performed only by qualified persons.

NOTE: Turn OFF the instrument before removing or replacing assemblies or connectors.

Power Supply Troubleshooting Flowchart



START HERE

Fan

If the fan does not seem to be operating normally (at steady speed, either high or low) and these conditions are true:

- A15 rear panel red LED OFF, green LED ON (see NO TAG)
- A8 LEDs (all) ON (see NO TAG)

Refer to *Fan Troubleshooting*, page 8–8.

Power Supply Error Messages

If any of the following error messages are displayed, take action as recommended:

Power Supply Hot. Check the temperature of the operating environment: it should be less than +55°C (131°F). Make sure the fan is operating at high speed and there is at least 15 cm (6 in) spacing behind and all around the instrument. If the fan is at slow speed or not working, refer to *Fan Troubleshooting*, page 8–8.

Air Flow Restricted: Check Fan Filter. Clean the fan filter. For best air flow and cooling, operate the instrument with all of the covers in place. If the problem persists, continue with *Check A15 Preregulator and Loads*, next.

Power Supply Shut Down! One or more supplies on A8 has been shut down due to overcurrent, overvoltage, or undervoltage. Continue with *Check A15 Preregulator and Loads*, next.

CHECK A15 PREREGULATOR AND LOADS

Check A15 Green LED on Rear Panel

If the green LED is not ON, check the fuse, line selector, and line voltage (see NO TAG).

If the green LED is not ON and the fuse, selector and voltage are correct, replace A15.

If the green LED is ON, continue.

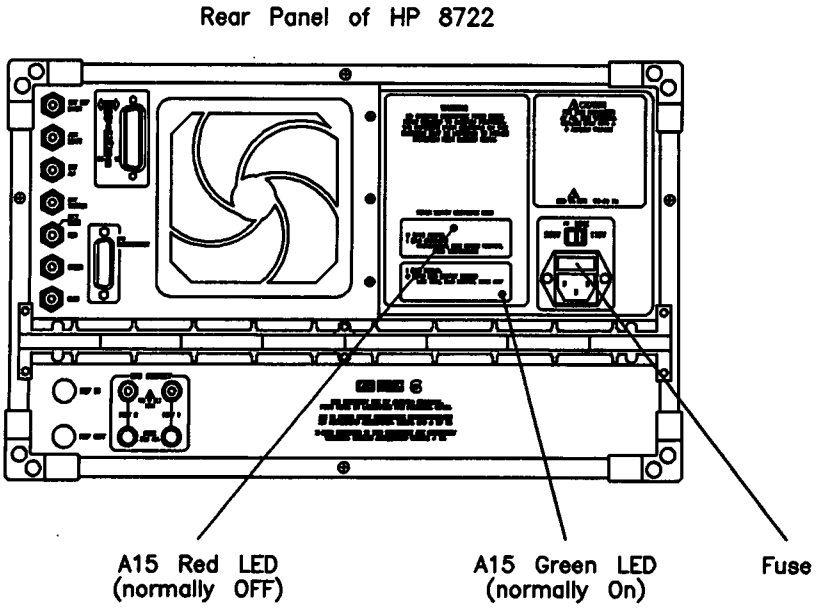


Figure 8–1. Location of A15 Power Supply Diagnostic LEDs

Disconnect A15W1 and Check Red LED

Disconnect A15W1 from A8 and observe the A15 red LED on the rear panel:

- If the red LED is OFF, refer to *Check A15W1 Voltages.* (See Figure 8–2).
- If the red LED is not OFF, the fault is probably in A15, +5VDIG, +5VCPU, or one of the assemblies loading these supplies. Continue with the next check.

Check A15 and +5V Loads

Remove the A8 through A14 assemblies (see label on instrument top cover) and turn on the instrument.

- If the A15 red LED is OFF, reinsert the assemblies one at a time, starting with A8, until the A15 red LED is ON (disregard the A8 green LEDs). Replace the assembly that turns ON the A15 red LED.
- If the A15 red LED is not OFF (with A8 to A14 removed), reinsert A8 to A14 and then remove the remaining +5V loads one at a time in the order shown below until the A15 red LED goes OFF.
- A51: Disconnect W12 (the ribbon cable going from A17 to A51, see label on top cover). If the A15 red LED goes OFF, the fault is in the lower box: continue with *Remove A51 Loads*.
- A1/A2 and A16 (see label on top cover or *Disassembly and Replacement Procedures* section for location): replace the assembly whose removal causes the A15 red LED to go OFF.

If the A15 red LED is not OFF (with A1, A2, A8 to A14, A16, and W12 disconnected), replace the A15 preregulator.

Remove A51 Loads

Remove power from the following components in the lower box.

A60/A61/S4 bias tees and transfer switch	(at A56J2)
A52 pulse generator	(at A51J4)
A66 B sampler	(at A51J10)
A65 A sampler	(at A51J9)
A64 R sampler	(at A51J11)
A69 step attenuator	(at A51J2)
A53/A57 mixer/amp and cavity oscillator	(at A51J3)
A55 YIG 1 (2.55 – 20 GHz)	(plugs directly into A59)
A54 YIG 2 (20 – 40 GHZ)	

Reconnect W12 and observe the A15 red LED:

- A15 red LED OFF: replace the cables one at a time. Replace the assembly that turns ON the A15 red LED.
- A15 red LED not OFF: replace A51.

Check A15W1 Voltages

Measure the output voltages of A15 at A15W1P1 (see Figure 8–2 for values). If any of the voltages are out of tolerance, replace A15. If all the voltages are correct, continue with *Check A8 Post–Regulator and Loads*.

A15W1P1 Voltages

Pin	
1	N/C
2	+100 to +125
3, 4	+22.4 to +33.6
5, 6	—22.4 to —33.6
7	N/C
8	+9.4 to +14
9, 10	—9.4 to —14
11	+32 to +48
12	N/C

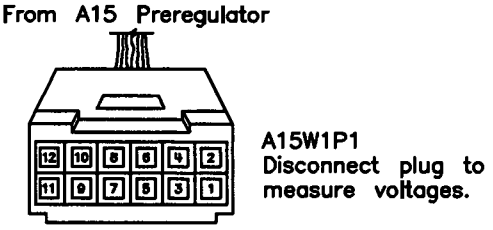


Figure 8–2. Voltages at A15W1P1

CHECK A8 POST–REGULATOR AND LOADS

Reconnect A15W1. If all nine of the A8 post–regulator green LEDs are not ON, go to *A8 LEDs Are Not All ON*. Otherwise, if the A15 red LED is still not OFF, continue.

Check Fan

If the fan is not operating normally, go to *Fan Troubleshooting*.

Check Display

Remove the W42 display power cable from A8 (see Figure 8–3) and check the A15 red LED:

- A15 red LED not OFF: reconnect W42 and continue with *Check Assemblies Loading +7.5V Supply.*
- A15 red LED OFF: reconnect W42, disconnect A18W1 from A19,
  - A15 red LED OFF: replace the A18 display assembly.
  - A15 red LED not OFF: replace the A19 GSP assembly.

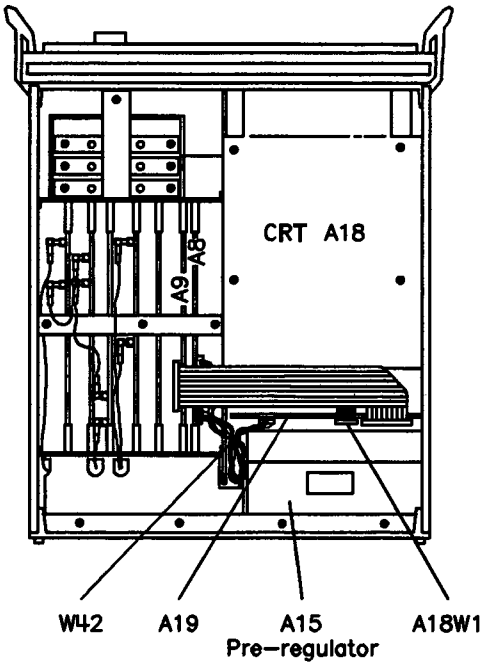


Figure 8–3. Location of W42 Display Power Cable

Check Assemblies Loading +7.5V Supply

Remove the A9, A10, A12, A13 and A14 assemblies.

- A15 red LED OFF: reinsert the assemblies one at a time until the A15 red LED goes ON (disregard the A8 green LEDs). Replace the assembly that turns the LED ON.
- A15 red LED not OFF: either the A8 post–regulator or the A17 motherboard is faulty; check them for shorts and solder bridges. Refer to the *Power Supply Block Diagram*, at the end of this section, for help.

A8 LEDs ARE NOT ALL ON

When the A8 LEDs are not all on, the fault could be in the A8 assembly itself, in an upper box assembly, in a lower box assembly or in the display.

Check A8 Alone

Remove A8 from its cavity but keep A15W1 connected. Disconnect the W42 display power cable from A8J11 and short test point AGND to chassis ground with a clip lead. Test points and LEDs are identified on the circuit board and in Figure 8–4.

- Any A8 LEDs (except +5VD) not ON: check the fuses along the top edge of A8, pull any burnt ones out of their sockets and replace them. If any fuse burns out again or any LEDs are still not ON, replace A8.
- All A8 LEDs (except +5VD) ON: the problem is not in A8. Reinsert A8, reconnect the display cable, and remove the short to chassis ground.

Check Upper Box Assemblies

Remove these assemblies from the instrument: A9, A10, A11, A12, A13, and A14 (see top cover label). Turn the instrument on and observe the A8 LEDs:

- All A8 LEDs ON: reinsert the assemblies one at a time and replace the assembly that produces the "LEDs not all ON" condition.
- All A8 LEDs not all ON: reinsert the assemblies and continue.

Check Lower Box Assemblies

Disconnect W12 (the A51 ribbon cable) and turn on the instrument.

- All A8 LEDs ON: reconnect W12 and disconnect the cables to these loads: A60, A61, S4, A52, A66, A65, A64, A69, A51, A57, and A55 (see top cover label).Reconnect the assemblies one at a time and replace the assembly that produces the "LEDs not all ON" condition.
- If disconnecting A51 fixed the problem, then disconnect by unplugging A55, A53, and A58.
- All A8 LEDs not ON: reconnect W12 and check the display.

Check the Display

Disconnect W42 (the display power cable) and turn on the instrument.

- All A8 LEDs ON: reconnect W42, disconnect A18W1 from A19,
- All A8 LEDs ON: replace the A18 display assembly.
- All A8 LEDs not OFF: replace the A19 GSP assembly.
- A8 LEDs not all ON: one of the *remaining* loads or the motherboard is faulty. Reconnect W42 and continue.

Check the Remaining Loads and Traces

Use the shutdown disable feature to determine which remaining load or trace may be faulty.

Briefly Disable the Shutdown Circuitry. Connect test point SDIS to chassis ground with a jumper wire. Turn the instrument on and note any LEDs that are not ON. IMMEDIATELY REMOVE THE JUMPER WIRE.

Identify the Faulty Assembly. Refer to the *Power Supply Block Diagram* (at the end of this section) and note the mnemonics of the voltages of any A8 LED that was not ON in the previous step. The assemblies that have not yet been checked are these:

A4, A5, A6, A1/A2, A16 (unchecked assemblies)

If the mnemonics noted above indicate a particular assembly could be faulty, check it first. Otherwise remove each of the unchecked assemblies one at a time in the order listed. Turn on the instrument and observe the A8 LEDs. Replace the assembly that turns ON all of the LEDs.

If, after removing all of the above assemblies, the A8 LEDs are not all ON, inspect A17, the motherboard. Look for solder bridges and shorted traces, especially the traces that carry the supplies whose LEDs faulted when A8TP5 was grounded earlier.

NOTE: This is the end of the troubleshooting sequence. The following procedures are branches of the preceding sequence and other sections.

FAN TROUBLESHOOTING

The fan as well as other assemblies share the 18 volt supplies from A15. The ±18 volts from the A15 is controlled on the A8 to produce the correct fan speed to regulate instrument internal temperature.

Measure A8 Fan Voltages

Remove A8 from the motherboard but keep A15W1 connected. Remove the W42 display power cable and short test point AGND to chassis ground with a clip lead. Turn on the instrument and measure the voltages as indicated.

Measurement Point	Measurement Range (volts)
A8P1 pin 31	+5.3 to +15.4 (this voltage is temperature dependent)
A8P1 pin 32	—13.5 to —14.9

If the preceding measurements are within range, replace the fan.

Measure A15 Fan Voltages

If you haven't already measured the 18 volt supplies from A15, disconnect A15W1 from A8. Turn on the instrument and measure the **unloaded** voltages at A15W1P1 pins 1 through 4 (see Figure 8–2).

If the measurements are within range, replace A8.

If the measurements are not within range, replace A15.

DISPLAY POWER TROUBLESHOOTING

This procedure is an entry point from the *Digital Control* section and assumes the following:

- The supply voltages are faulty at A18,
- The A15 rear panel red LED is OFF and the green LED is ON, and
- All A8 green LEDs are ON.

If these assumptions are false, go back to the beginning of *Power Supply.*

Verify A8 Display Voltages

Remove A8 from the motherboard but keep A15W1 connected. Remove the W42 display power cable and short A8TP2 (AGND) to chassis ground with a clip lead. Turn the instrument on. Refer to Table 8–1 and NO TAG to continue.

Table 8–1. Display Voltage Measurements

Step	Measurement Pt.	Voltage Range	Observation: Action
1	A8TP1 (+65V)	+64.6V to +65.4V	bad: disconnect A15W1 and do step 3
2	A8P1 pins 18, 19	+4.9V to +5.3V	good: plug A8 into motherboard and do step 4 bad: replace A15
3	A15W1P1 pins 1,2 (+65V)	+100V to +125V	good: replace A8 bad: replace A15
4	A8TP3 (+5VD)	+4.9V to +5.3V	bad: replace A8

**Suspect cable W42 if the voltage is good at A8.

TEST POINT VOLTAGES

This procedure is an entry point from *Isolate Faulty Group*. Measure the DC voltages at the A8 test points as shown in NO TAG.

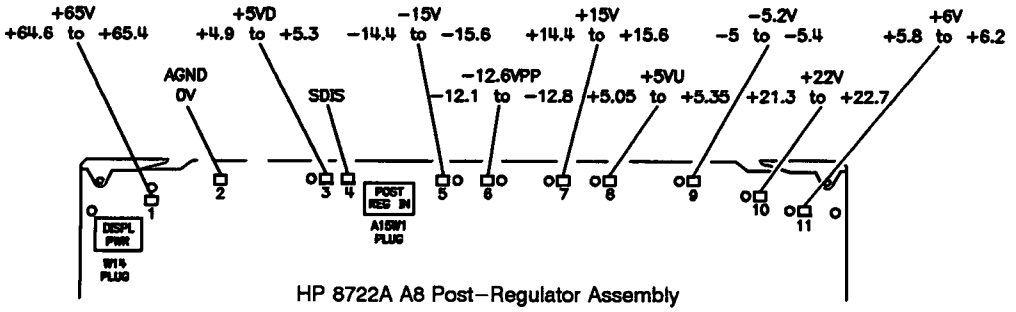


Figure 8−4. A8 Post−Regulator Test Point Voltages

In Case Of Difficulty

If any of the A8 test point voltages is not within the range shown in NO TAG, determine which assembly, A8 or A15, is faulty.

NOTE: Turn OFF the instrument before removing or replacing any assemblies or connectors.

1. If the +5VD voltage at A8TP4 is out of tolerance, put the A8 assembly on an extender board and measure the voltage at A8P1 pins 18 and 19.
   - correct voltage (+4.9V to +5.3V) at A8P1 pins 18, 19: replace A8
   - incorrect voltage at A8P1 pins 18, 19: replace A15.
2. If the voltage at any test point except A8TP4 is out of tolerance, disconnect A15W1 from A8 and measure the voltages at A15W1P1 (see Figure 8−5).

HP 8719 HP 8720 Pin	A15W1P1 Voltages
1	N/C
2	+100 to +125
3, 4	+22.4 to +33.6
5, 6	—22.4 to —33.6
7	N/C
8	+9.4 to +14
9, 10	—9.4 to —14
11	+32 to +48
12	N/C

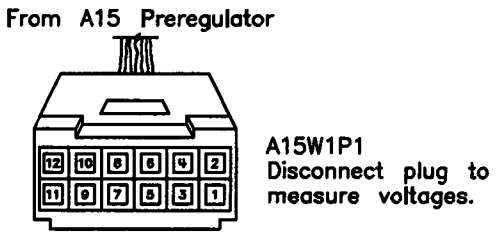
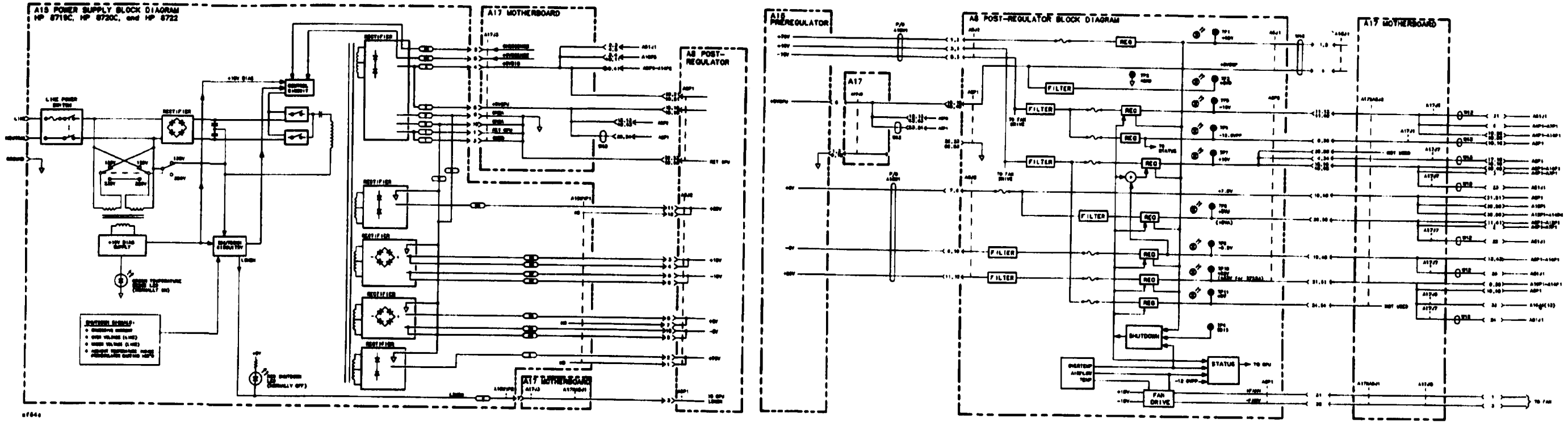


Figure 8–5. A15W1P1 Voltages

- correct voltages at A15W1P1: A8 or one of its loads is faulty. To troubleshoot, go to the paragraph titled *A8 LEDs Are Not All On*. Perform that procedure **measuring** the power supply voltages (instead of observing the A8 LEDs).
- incorrect voltages at A15W1P1: replace A15.



A15 POWER SUPPLY BLOCK DIAGRAM

Chapter 9. Digital Control

INTRODUCTION

Use this section to determine which digital control assembly of the instrument is faulty. The digital control assemblies are:

- A1 front panel
- A2 front panel interface
- A9 CPU
- A10 digital IF
- A16 rear panel
- A18 display
- A19 GSP
- A51 test set interface

Abus Test Failure

If the abus (analog bus) test failed in *Isolate Faulty Group*, perform the analog bus correction constant routine as described in the *Adjustments* section. If the instrument is not phase locking, tests may take much longer than normal to run. Ignore phase lock problems and continue. Press [SYSTEM] SERVICE MENU TESTS [1] [9] [x1] EXECUTE TEST to run the abus test again. If it fails, replace the A10 assembly and return to *Isolate Faulty Group*. If it passes, return to *Isolate Faulty Group*.

Fatal Errors

If the CRT displays a fatal error, go to *Fatal Error Troubleshooting*.

HP-IB Failures

If you suspect HP-IB failure, go to *HP-IB Troubleshooting*.

PRELIMINARY CHECKS

NOTE: Be sure the A9CC jumper is in the "normal" position for these procedures.

A9 CPU CHECK

7. Check LED Pattern After Cycling Power

Cycle the power on the analyzer and observe the four red LEDs (labeled RUN–1–2–4) on the top edge of the A9 CPU board. The RUN LED should be on after the instrument is powered up.

If the RUN LED is not on, replace the A9 CPU after verifying the power supply.

8. Check LED Pattern With Preset Key Held In

Press and hold down the [USER PRESET] key while observing the four LEDs on A9. The RUN LED should be off, and the 1–2–4 LEDs should stop blinking and display a random pattern of on/off.

9. Check LED Pattern After Preset Key Is Released

Release the [USER PRESET] key and watch for the following sequence:

All four LEDs should turn on for about 1 second. The run LED should stop blinking and display a random pattern of on/off.

If this is observed, go to *Display Check*.

If the RUN LED does not remain on, and the A9CC jumper is in the "normal" position, replace the A9 CPU assembly and repeat the three LED pattern checks.

If the RUN LED remains on but the 1–2–4 LEDs are held in any of the patterns in Table 9–1, and the A9CC jumper is in "normal" position, replace the A9 firmware ICs. (Firmware ICs are not individually replaceable.) Replacement kits are listed in the *Replaceable Parts* section.

Table 9–1. LED Code and Pattern Versus Test Failed

LED Code Sum					Message Displayed on CRT	Faulty Component
	RUN	1	2	4		
	●	●	○	○	ROM 1L FAIL	U24
	●	●	○	○	ROM 1M FAIL	U4
	●	●	●	○	ROM 2L FAIL	U25
	●	●	●	○	ROM 2M FAIL	U5

DISPLAY CHECK

If the display is not bright and focused with legible labels, skip to *Display Troubleshooting*, otherwise continue.

FRONT PANEL CONTROL CHECK

Press [USER PRESET]. All six upper front panel LEDs should turn ON, and within five seconds after release, five should turn OFF (CH 1 or CH 2 LED stays on depending on stored user preset state).

Press [CH 2] and [CH 1]. As each key is pressed, the LED next to it should turn ON (and the other LED turn OFF).

- If either of these checks fails, go to *A1/A2 Front Panel Troubleshooting*.

Press [MEAS] Refl: REF S22 if a1 LED is on after user preset, or press Refl: FWD S11 if a2 LED is on after user preset, and observe the LEDs on the lower front panel.

- If the a1 LED turns OFF and the a2 LED turns ON and a click is audible, continue with *Diagnostic Checks*.
- If the LEDs do not switch or a click is not audible, suspect a faulty transfer switch or associated cables. Press [MENU] POWER RANGE 3-30 TO -20 RANGE 4-35 TO -25 and listen for the click of the attenuator. Attenuator activity indicates that the W12 cable is good; troubleshoot S4 and its associated cables. Attenuator inactivity indicates a problem with W12 (the lower box control and power cable).

DIAGNOSTIC CHECKS

The analyzer incorporates 20 internal diagnostic tests. Most tests can be run as part of one or both major test sequences: all internal (#0) and preset (#1). A few tests can be run only singly. To run the ALL INTERNAL test, press [SYSTEM] SERVICE MENU TESTS [0] [x1] EXECUTE TEST. Then press [1] [x1] to see the results of the PRESET test. If either sequence fails, press the [▲] or [▼] keys to find the first occurrence of a FAIL message for tests 1 through 20. Refer to Table 9-2 for further troubleshooting information.

Table 9–2. Internal Diagnostic Tests with Commentary

Test	Sequence[1]	Probable Failed Assembly[2]: Comments and Troubleshooting Hints
0 All Int	– – –	– –:Executes tests 3–11, 13–16, 20.
1 Preset	– – –	– –:Executes tests 2–11, 14–16. Runs at power–on or preset.
2 ROM	P	A9:Repeats on fail; refer to Table 1 to replace ROM or A9.
3 CMOS RAM	P,AI	A9:Replace A9.
4 Main DRAM	P,AI	A9:Repeats on fail; replace A9.
5 DSP Wr/Rd	P,AI	A9:Replace A9.
6 DSP RAM	P,AI	A9:Replace A9.
7 DSP ALU	P,AI	A9:Replace A9.
8 DSP Intrpt	P,AI	A9/A10:Remove A10, rerun test. If fail, replace A9. If pass, replace A10.
9 DIF Control	P,AI	A9/A10:Most likely A9 assembly.
10 DIF Counter	P,AI	A10/A9/A12:Check analog bus node 17 for 1 MHz. If correct, A12 is verified; suspect A10.
11 DSP Control	P,AI	A10/A9:Most likely A10.
12 Fr Pan Wr/Rd	– – –	A2/A1/A9:Run test 23. If fail, replace A2. If pass, problem is on bus between A9 and A2 or on A9 assembly.
13 Rear Panel	AI	A16/A9:Disconnect A16, and check A9J2 pin 48 for 4
		MHz clock signal. If OK, replace A16. If not, replace A9.
14 Post–reg	P,AI	A15/A8/Destination assembly:See Power Supply section.
15 Frac–N Cont	P,AI	A14:Replace A14.
16 Sweep Trig	P,AI	A14,A10:Most likely A14.
17 ADC Lin	– – –	A10:Replace A10.
18 ADC Ofs	– – –	A10:Replace A10.
19 ABUS Test	– – –	A10:Replace A10.
20 FN Count	AI	A14/A13/A10:Most likely A14 or A13, as previous tests check A10. See Source section to troubleshoot.

1 P = part of PRESET sequence;
AI =part of ALL INTERNAL sequence.
2 in decreasing order of probability.

NOTE: Refer to Service Key Menus for a description of each of these tests.

FATAL ERROR TROUBLESHOOTING

A fatal error message indicates that the A9 assembly processor is failing its own self–test. This may be due to either faulty data or address lines or a faulty A9 assembly.

To troubleshoot a fatal error, first remove all data and address destination assemblies by removing or disconnecting these items:

A1, A2, A10, A12, A13, A14, A16, W12.

- If the instrument still displays a fatal error, either replace the A9 assembly or inspect the motherboard (A17) for faulty traces.
- If the instrument no longer displays a fatal error, replace the assemblies one at a time until the fatal error reappears. When it does reappear, the likelihood is that a shorted data or address line exists on that assembly.

DISPLAY TROUBLESHOOTING

If the display is faulty in intensity or focus, perform the *Display Intensity and Focus Adjustments* in the *Adjustments* section. If this does not resolve the problem, continue.

NOTE: Magnetic fields will cause distortion of the color display. Typical sources of magnetic fields are magnetized work benches, electric motors, power supplies, etc. Should you experience distortion, move the analyzer to a different location. If the problem does not go away, perform the display degaussing routine in chapter 5.

Measure Display Power Supply Voltages Entering A19

Measure the power supply voltages entering the A19 assembly coming from the A8 assembly. Check pins 1 and 2 for +65 ±0.4 V, and pin 6 for +5.16 ±0.4 V. See Figure 9–1.

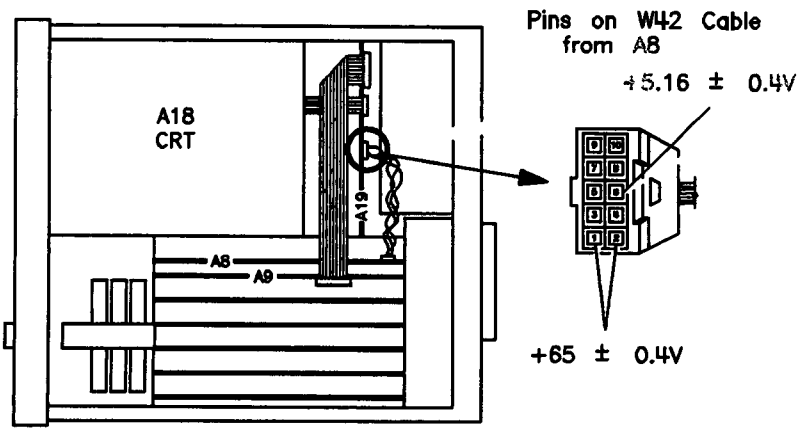


Figure 9–1. A19 GSP Voltages from A8

- Voltages incorrect: return to the "Power Supply" section.
- Voltages correct: continue.

Display Power Supply Troubleshooting

Measure the display power supply voltages on the A19 GSP assembly. Check pins 2, 4, and 6 for +65 ±0.4 V. (See Figure 9–2)

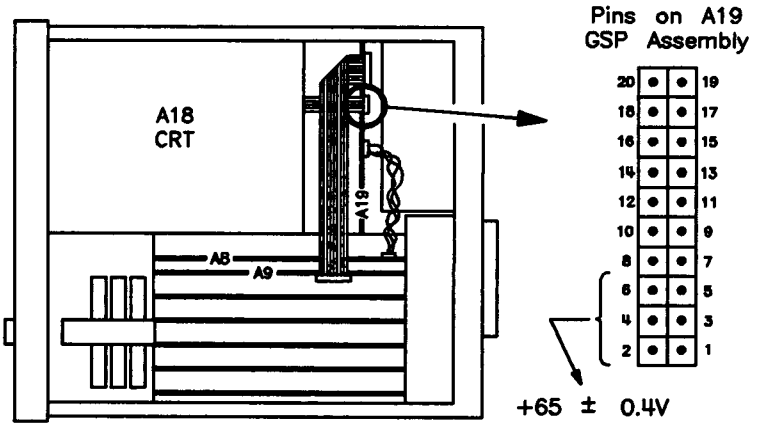


Figure 9–2. Display Power Supply Voltages from A19

- Voltages incorrect: replace A19 GSP assembly.

- Voltages correct: continue with "Run Display Test 55."

Run Display Test 55

On the analyzer, press [RECALL] RECALL FAC PRESET (softkey 7) [SYSTEM] SERVICE MENU (softkey 8) TESTS (softkey 1) [5] [5] [x1]. The CRT should display: `55 Disp/cpu com -ND-`

Press EXECUTE TEST (softkey 1). As soon as you press the key, all of the LEDs in the top box should flash and the display should blank. Also note,

- All LEDs (in the top box) remain OFF, display blank: go to *Run Remaining Display Tests.*
- Some LEDs ON or display not blank: continue.
- Press [RECALL] RECALL FAC PRESET (softkey 7) to abort the test.

Inspect Ribbon Cable and Repeat Display Test 55

Inspect the A9–A19 ribbon cable for a loose connection. Repeat "Run Display Test 55" and observe the display.

- All LEDs (in the top box) remain OFF, display blank: go to *Run Display Tests.*
- Some LEDs ON or display not blank: continue.

Perform CPU – GSP Communication

Disconnect the A19 end of the A9–A19 ribbon cable. Use an oscilloscope to verify a pulse train pattern of about 3 to 4V amplitude is transferring from the A9 CPU through the cable. The pulse train should be varying (irregular) if the instrument is in continuous sweep and regular (periodic) if the instrument is in hold. Place the instrument in hold by pressing [MENU] TRIGGER (softkey 4) HOLD (softkey 1). Go back to continuous by pressing [MENU] TRIGGER (softkey 4) CONTINUOUS (softkey 4). The pattern is found on pins 3 through 10, and 13 through 20. See Figure 9–3.

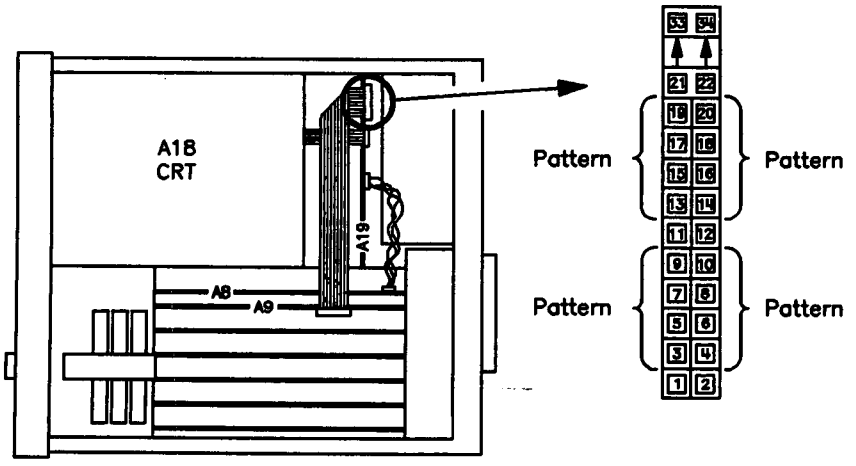


Figure 9–3. A9 CPU Walking One Pattern

- Signal not present at A19 end of cable:

  Check for signal at A9 connector of the ribbon cable:
  - Signal not at A9: replace A9 assembly.
  - Signal at A9: replace cable.

- Signal present at A19 end of cable: reconnect cable then continue.

Run Remaining Display Tests

Store an instrument state in REG 1 by pressing [RECALL] RECALL FAC PRESET [SAVE] SAVE REG 1

Run display tests 56 through 61. In each test the front panel LEDs should flash and then turn OFF. The display should blank (except in test 61 where it dims). After executing the test press [RECALL] RECALL REG 1 (softkey 1) [SYSTEM] SERVICE MENU (softkey 8) TESTS (softkey 1) to see the results of the test.

Press [RECALL] RECALL REG 1 (sortkey 1) [SYSTEM] SERVICE MENU (softkey 8) TESTS (softkey 1) to observe the test result. Repeat for tests 56 through 61. Based on the results below, you will replace either A19 or A18.

If some top box LEDs remain ON or the display does not blank (or dim): Replace A19 assembly.

If (1) the display power supply is ok, and

(2) the intensity or focus or vertical adjustment is ineffective, and

(3) all LEDs (except a1) go OFF and the display is blank (or dim) on tests 56 through 61:

Replace A18.

HP–IB TROUBLESHOOTING

This procedure assumes that checks performed in the *Troubleshooting* section have isolated an HP–IB problem to the analyzer. Now perform the following test to check the internal communication path between the A9 CPU and the A16 rear panel. (This test does not check HP–IB paths external to the analyzer.)

Press [SYSTEM] SERVICE MENU TESTS [1] [3] [x1] EXECUTE TEST to perform internal test 13 (rear panel) and note the results:

- Test 13 fails: the problem is most likely the A16 rear panel assembly. If the A9 CPU assembly has not been verified by checking its self–test results, press TESTS and scroll through tests 2 to 11. If any test from 2 to 11 has failed, refer to Table 3, *Internal Diagnostic Tests*, earlier in this section. If tests 2 to 11 have passed, replace A16.
- Test 13 passes: the A9 CPU assembly can communicate with A16 to a 50% confidence level. If you are confident of the *Troubleshooting HP–IB Systems* checks performed in the *Troubleshooting* section, replace A16.

A1/A2 FRONT PANEL TROUBLESHOOTING

Press [USER PRESET] and observe the six upper front panel LEDs:

- No LEDs ON or all six LEDs remain ON, see *No Front Panel Control*.
- Five seconds after [USER PRESET], there should be only one channel LED on (either CH1 or CH2), and one S–parameter LED on (either a1 or a2). If more than these 2 LEDs are on, see *Stuck Key*.

No Front Panel Control

If all six front panel LEDs never turn ON, or if they remain ON, there is a control problem between A9 and A1/A2.

Remove the A1/A2 front panel and visually inspect the ribbon cable that connects the front panel to the motherboard. Also, inspect the interconnecting ribbon cable between A1 and A2. Make sure the cables are properly connected. Replace any cables that appear bad.

If a controller is available, write a simple command to the analyzer. If the analyzer successfully implements the command, the problem is probably on A1/A2 or is a faulty A1/A2 ribbon cable to motherboard connection.

Stuck Key

Following [USER PRESET], with one exception (noted later), the analyzer signals stuck keys in two ways:

- CH 1 and A1 LEDs are not the only LEDs ON five seconds after PRESET.
- All six LEDs flash ON and then OFF within a few seconds of PRESET (five seconds is normal).

Stuck keys cause the instrument to enter the front panel error codes test and generate a unique pattern of front panel LEDs for each key pressed or stuck. To determine which key is stuck, match the pattern of LEDs ON to Table 5. Free the stuck key or replace the A1 front panel.

The exception is the case of a stuck USER PRESET key. In this instance, the A9 CPU 1, 2, 4 and CH2 LED remain ON.

Table 9–3. Front Panel Key Codes (1 of 2)

Decimal Number	LED Pattern						Key	Front Panel Block
	CH1	CH2	R	L	T	S		
0							CAL	Response
1						●	3	Entry
2					●		k/m	Entry
3					●	●	DISPLAY	Response
4				●			AVG	Response
5				●		●	2	Entry
6				●	●		1	Entry
7				●	●	●	Softkey 3	Softkey
8			●				Softkey 5	Softkey
9			●			●	9	Entry
10			●		●		G/n	Entry
11			●		●	●	CH 1	Active Channel
12			●	●			CH 2	Active Channel
13			●	●		●	8	Entry
14			●	●	●		7	Entry
15			●	●	●	●	Softkey 1	Softkey
16		●					STOP	Stimulus
17		●				●	SAVE	Instrument State
18		●			●		RECALL	Instrument State
19		●			●	●	MENU	Stimulus
20		●		●			START	Stimulus
21		●		●		●	COPY	Instrument State
22		●		●	●		SYSTEM	Instrument State
23		●		●	●	●	Softkey 6	Softkey
24		●	●				SCALE REF	Response
25		●	●			●	6	Entry
26		●	●		●		M/u	Entry
27		●	●		●	●	MEAS	Response
28		●	●	●			FORMAT	Response
29		●	●	●		●	5	Entry
30		●	●	●	●		4	Entry
31		●	●	●	●	●	Softkey 2	Softkey
32	●						SPAN	Stimulus
33	●					●	◆	Entry
34	●				●		ENTRY OFF	Entry
35	●				●	●	CENTER	Stimulus
36	●			●			Softkey 8	Softkey
37	●			●		●	◆	Entry
38	●			●	●		LOCAL	Instrument State
39	●			●	●	●	Softkey 7	Softkey
40–47	Not Used							
48	●	●					BACK SP	Entry
49	●	●				●	—	Entry

Table 9–3. Front Panel Key Codes (2 of 2)

Decimal Number	LED Pattern						Key	Front Panel Block
	CH1	CH2	R	L	T	S		
50	●	●			●		x1	Entry
51	●	●			●	●	MKR	Response
52	●	●		●			MKR FCTN	Response
53	●	●		●		●	.	Entry
54	●	●		●	●		0	Entry
55	●	●		●	●	●	Softkey 4	Softkey

SOURCE

Chapter 10. Source

START HERE

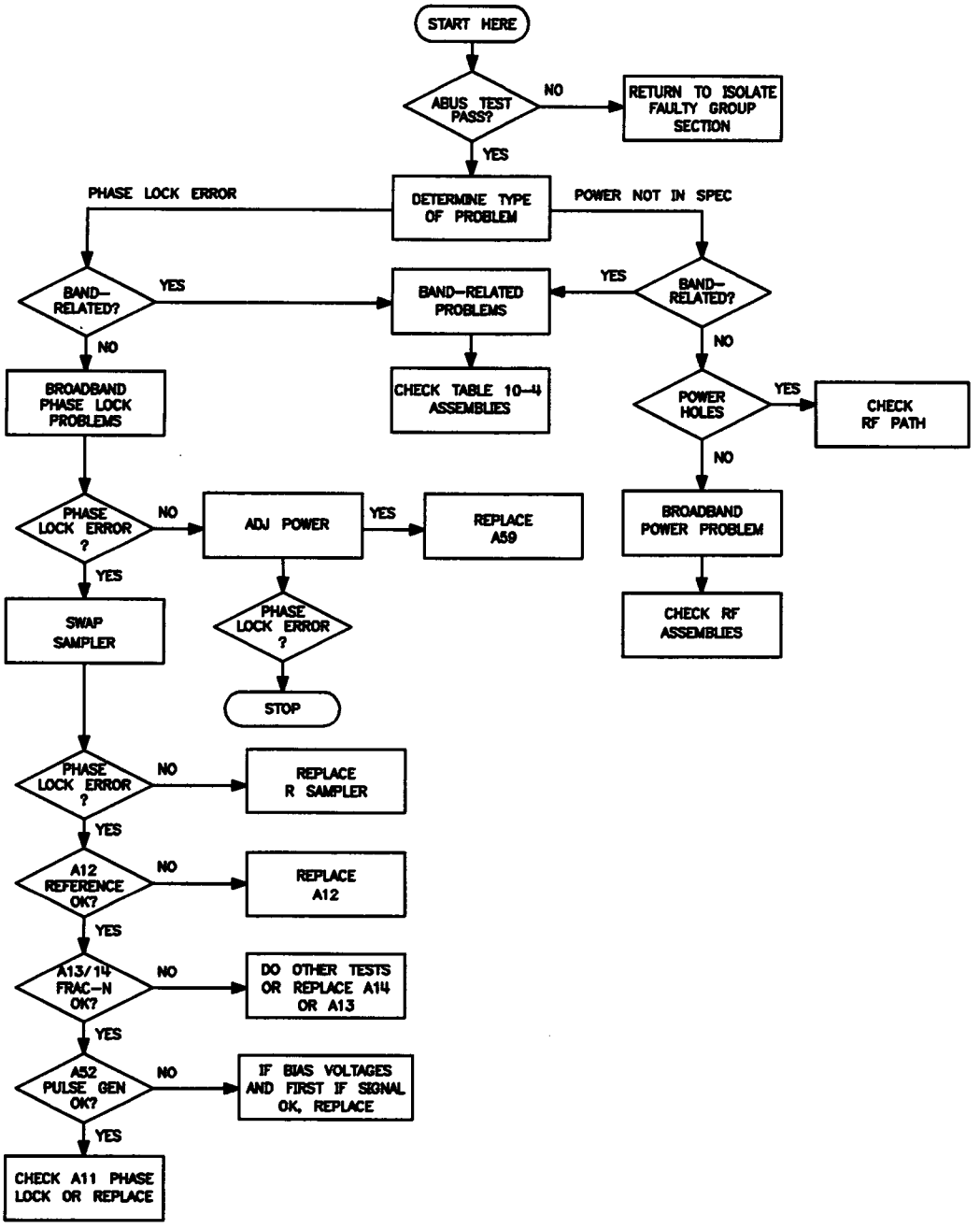
The use of this section is based on several assumptions:

- The analog bus has passed test #19. (If not, press [SYSTEM] SERVICE MENU TESTS [1] [9] [x1] EXECUTE TEST . If the test fails, return to the *IFG* (*Isolate Faulty Group*) section. If the test passes, continue.)
- A phase lock error message was observed in *IFG* (go to *Phase Lock Error Message Displayed*, next) or
- Incorrect power levels were observed in *IFG* (go to *Power Not Within Specifications*) or
- A performance test or adjustment failed (continue).

Phase Lock Error Message Displayed

Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU INPUT PORTS ANALOG BUS [9] [x1] to view the 0.25V/GHz signal to the YIG oscillator drives. Note that for each band, the waveform should start and stop exactly as shown in Figure 10−1, with only one ramp in each band. A problem in one band should not affect the appearance of the waveform in other bands.

Source Troubleshooting Flowchart



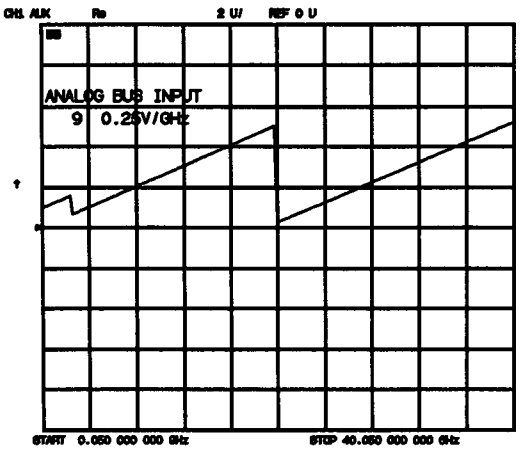


Figure 10–1. 0.25V/GHz Waveform at Abus Node 9

- If the waveform appears normal in one but not all frequency bands, go to *Band–Related Problems*.
- If the waveform appears abnormal in all frequency bands, refer to *Broadband Phase Lock Problems*, below.

Power Not Within Specifications

Perform Power adjustments:

- Low band power level adjustments.
- Blanking adjustments.
- Power linearity correction constants.
- If power holes exist, use the block diagram (in *Troubleshooting*) and the location diagram (on the instrument cover) to check the cables and connections in the RF path.
- If power levels are incorrect (are not ±3 dBm of setting) in only one or two bands, go to *Band–Related Problems*.
- If power levels are incorrect in all bands, go to *Broadband Power Problems*.

BROADBAND PHASE LOCK PROBLEMS

Phase lock problems can be caused by incorrect pretune correction constants. Perform the source pretune correction constant procedure (service test 43, see *Adjustments*) to fix this potential problem. Then press [RECALL] RECALL FAC PRESET to see if the phase lock problem persists. If the phase lock problem persists, continue. It could be caused by a fault in one of these source assemblies:

A11 phase lock
A12 reference
A13 fractional–N analog
A14 fractional–N digital
A51 test set interface
A52 pulse generator
A58 M/D/S
A64 R sampler
S1 PIN switch
A59 source interface board

Swap Samplers to Check A64 R Sampler

At A66J3 (the B sampler, see location diagram or the *Replacement Procedures* chapter of this manual), replace the IF OUT cable with the IF OUT cable removed from A64J3 (the R sampler). Press [MENU] CW FREQ POWER RANGE 1 [–] [1] [0] [x1] [MEAS] Refl: REV S22 (Ignore the trace). If the phase lock problem persists, the R sampler was not the problem. Continue with *Check Open Loop Power.*

If the phase lock error message disappears, either the control voltage, bias voltage, RF signal or the R sampler itself is faulty. Check for about +0.2V on the green sampler control wire: if it is bad, replace A51. Check the +15V and —15V bias voltages (see *A51 Interface Power Supplies*): if they are bad, replace A51.

NOTE: If 2.4 mm flexible cables and 2.4 mm power sensors are not available, troubleshooting is possible using 3.5 mm equipment and 3.5 mm – 2.4 mm adapters, such as HP 11901D 2.4 mm (f) – 3.5 mm (m) and HP 11901B 2.4 mm (f) – 3.5 mm (f).

If the control and bias voltages are good, use a power meter and the flexible cable from the tool kit to troubleshoot the RF signal path. Press [SYSTEM] SERVICE MENU SERVICE MODES SRC TUNE DAC NUM HIGH BAND [4] [0] [0] [0] [x1] to enter the service mode. The RF power level out of the M/D/S, toward the R sampler, should be at least —22 dBm. If the power level is correct, replace the R sampler. If the power level is not correct, replace A58.

Check Open Loop Power

Verify that the source oscillators are working by measuring open loop power at the M/D/S output leading to the R sampler. Connect A power meter to the A64 end of W23. Press [SYSTEM] SERVICE MENU SERVICE MODES SRC TUNE DAC NUM XXX BAND [4] [0] [0] [0] [x1]. The power should be about –27 dBm for low band and mid band and –22 for high band. (You may have to change the DAC number slightly to achieve a good power reading).

If power is correct, proceed with *Check A12 Reference*. Otherwise, connect a power meter to the output of S1 leading to the A58 M/D/S, and check the power of the YIG oscillator. High band power should be greater than +3 dBm for DAC numbers from 2400 to 4095. Mid band power should be greater than +5 dBm for DAC numbers from 3300 to 4095. Low band power should be greater than −2 dBm for DAC numbers from 3700 to 4095. Low power in high or mid band indicates a problem with the associated YIG or switches. Trace back along the signal path to find where the power is lost. Activate the signal path under test by selecting the proper **DAC NUM XXX BAND** .

If no power is present, refer to *A51 Test Set Interface Power Supplies* at the end of this section, to check the bias voltages to the YIGs. If the voltages are correct, replace the YIG.

Check A12 Reference

Press [SYSTEM] **SERVICE MENU** **INPUT PORTS** **ANALOG BUS** [1] [4] [x1] **COUNTER: ANALOG BUS** to check the 100 kHz signal from A12: the counter should read .100 MHz.

Press [1] [7] [x1] to check the 1 MHz signal: the counter should read 1.000 MHz.

If either counter reading is incorrect, replace A12.

Check A14 Fractional−N

Fractional−N Checks With ABUS. Press [MENU] **SWEEP TYPE MENU** **LOG FREQ** [SYSTEM] **SERVICE MENU** **INPUT PORTS** **ANALOG BUS** [2] [1] [x1] and compare the fractional−N tuning voltage to Figure 10−2.

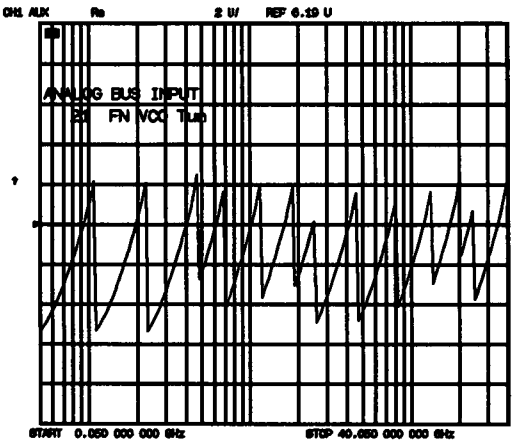


Figure 10−2. Fractional−N Tuning Voltage Waveform at Abus Node 21

Press COUNTER:FRAC N [MENU] CW FREQ and set the instrument to the frequencies of column one in Table 10–1.

Table 10–1. VCO Range Check Frequencies

Front Panel	Counter Value
50 MHz	119.988 to 120.012 MHz
109.999 MHz	239.975 to 240.024 MHz

- If the voltage waveform resembles Figure 10–2 but the counter values do not match Table 10–1, A14 is almost certainly faulty.
- If the voltage waveform and the counter values are bad, continue with *A14 VCO Exercise*, below.
- If the instrument passes both checks, the probability is greater than 90% that A13 and A14 are functional: go to *Check Pulse Generator* (or continue with *A14 VCO Range Check with Oscilloscope* to confirm).

A14 VCO Range Check with Oscilloscope

Connect an oscilloscope to A14TP1 (labeled VCO/2). Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU SERVICE MODES FRAC N TUNE ON. Vary the fractional–N VCO frequency with the RPG knob. If the waveforms do not resemble Figure 10–3 at the frequencies indicated, replace A14. (The amplitude of the waveforms will vary from 3V to 10V p–p.)

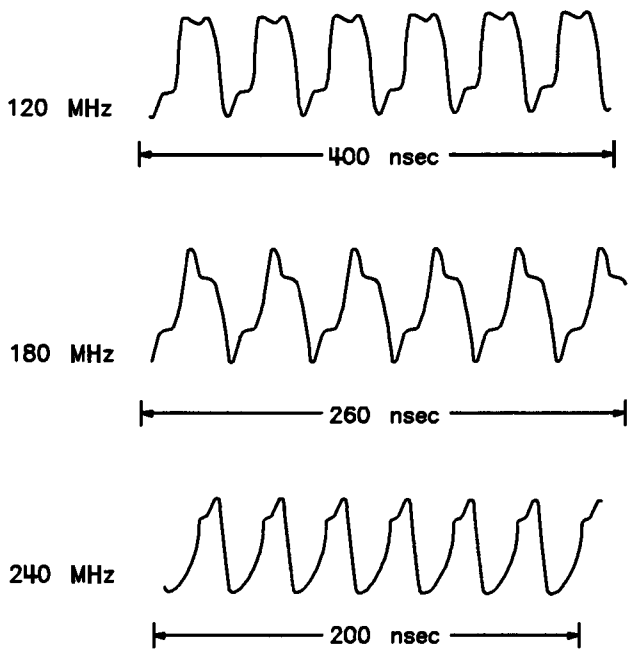


Figure 10–3. VCO/2 Waveforms at A14TP1

A14 VCO Exercise

The tuning voltage range of the VCO is approximately +1 to +14 volts. This procedure substitutes power supplies for the normal voltages from A13 to check the frequency range of the A14 VCO.

Remove the A13 assembly. Put the A14 assembly on an extender board. It is not necessary to connect the female cables while the A14 is on the extender board. Press [SYSTEM] SERVICE MENU INPUT PORTS ANALOG BUS COUNTER: ANALOG BUS to set the internal counter to the frac–N node. In turn, jumper each of the three supply voltages to A14TP14 and observe the frequency as shown in Table 10–2.

Table 10–2. VCO Exercise Matrix

Supply Test Point	Voltage Mnemonic	A14 Test Point	Counter Frequency
A8TP7	+15V	A14TP14	≅ 240 MHz
A8TP8	+5VU	A14TP14	≅ 155 MHz
A8TP2	AGND	A14TP14	≅ 105 MHz

If the frequency changes are not correct, replace A14.

A14 Divide–by–N Circuit Check

NOTE: The A13 assembly should still be out of the instrument and the A14 assembly on an extender board.

Jumper A14TP14 to the +5VU supply and connect an oscilloscope to A14J3 (labeled VCO/N OUT). Press [SYSTEM] SERVICE MENU SERVICE MODES FRAC N TUNE ON . Vary the fractional–N frequency from 120 MHz to 242 MHz.

- If the period of the signal does not vary from 7.5 µsec to 15.5 µsec, replace A14.
- If the period does vary as prescribed, remove the jumper and reinsert A14.

A14–to–A13 Digital Control Signals Check

Place A13 on the extender board and reconnect all of the flexible cables (the one to A14J1 is optional). The A14 assembly generates a TTL cycle start (CST) signal every 10 microseconds when the VCO is oscillating. Connect an oscilloscope to A14TP3 (CST). (Suggested vertical scale: 2.0V/div). Press [MENU] TRIGGER MENU HOLD to stop the 8722 sweep. This will make triggering on these waveforms easier. If there is no signal, replace A14.

Use the CST signal as an external trigger for the oscilloscope and observe the signals listed in Figure 10–4. Since these TTL signals are generated by A14 to control A13, check them at A13 first. The signals should look similar to the waveforms in Figure 10–4.

Mnemonic	A13 Location	A14 Location
CST	none	TP3
L FNHOLD	P2–2	P2–2
FNBIAS	P2–5	P2–5
API1	P2–32	P2–32
API2	P2–3	P2–3
API3	P2–34	P2–34
API4	P2–4	P2–4
API5	P2–35	P2–35
FNLATCH	P1–28	P1–58

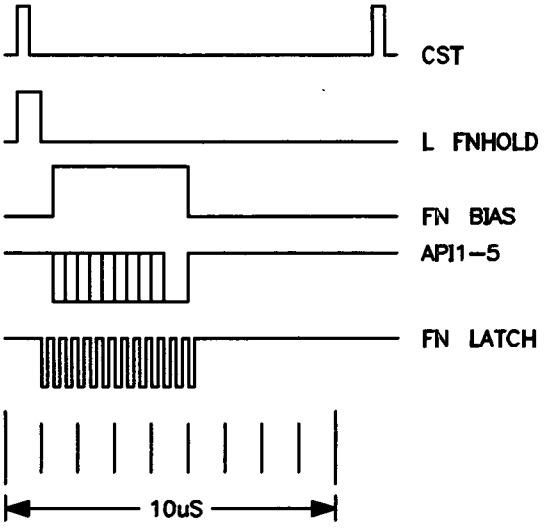


Figure 10–4. A14 TTL Signals at A14TP3

- If these signals are bad, replace A14.
- If they are good, replace A13.

A52 Pulse Generator Check

Monitor the 1st IF signal at the output of A65 A sampler: disconnect the SMB cable from A65 and connect an oscilloscope to the sampler IF output. Connect a frequency counter to port 1. Then perform these steps:

1. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU SERVICE MODES FRAC N TUNE [1] [8] [0] [M/u] to set the fractional−N VCO to 180 MHz.

2. Press SRC TUNE DAC NUM LOW BAND and rotate the RPG to change the DAC number to about 4013. Readjust the DAC number as required to measure an output frequency of about 0.91 GHz.

NOTE: The freq counter may have to be removed from port 1 to provide enough of a reflection to see on the scope.

Now the oscilloscope should display the IF signal as a sine wave of about 10 MHz. The actual frequency can be expressed as this equation:

Oscilloscope frequency = (counter frequency) —(180 MHz) x (harmonic)

3. Repeat step 2 using the information in the second line of Table 10−3.

Table 10−3. First IF Settings

DAC Number Band	Approximate DAC Number ON CRT	Approximate Source Frequency On Counter	Harmonic	Oscilloscope Frequency
Low	4013	0.910 GHz	5	10 MHz
Mid	3541	3.610 GHz	20	10 MHz
High	2529	20.17 GHz	112	10 MHz

- If the IF signals are proper, replace the A11.
- If the IF signals are improper, check the pulse generator bias voltages (see *A51 Interface Power Supplies*). If the voltages are correct, replace the A52 pulse generator.

BAND–RELATED PROBLEMS

Table 10–4 lists assemblies potentially responsible for band–related problems.

Table 10–4. Assemblies Potentially Responsible for Band–Related Problems

Low Band	Mid Band	High Band
A57	A55	A54
A53	S2	S1
S2	S3	A59
S3	A59	
A59		

NOTE: Problems in RF components, crimped RF cables, and improper connections which generally cause power holes in an RF signal may cause symptoms that indicate a band–related problem. Therefore, you should start by measuring power from S1. If the power here is good, then all of the components in Table 10–4 are verified. Continue troubleshooting with *Broadband Power Problems* to check other components. Also keep these points in mind.

- See the *Troubleshooting* tab to remove the instrument covers and pivot open the instrument.
- Cables of improper connections can be the problem in all cases.
- Use the flexible RF cable from the tool kit to measure power at otherwise inaccessible connections.
- Before replacing suspect assemblies, refer to *A15 Interface Power Supplies* to check bias voltages.

Low Band: first press [SYSTEM] SERVICE MENU SERVICE MODES SRC TUNE DAC NUM LOW BAND [4] [0] [0] [0] [x1] to measure power at S2J3. If greater than −5 dBm for DAC numbers from 50 MHz (DAC # ≃ 3650) to about 1.1 GHz (DAC # = 4095), troubleshoot the cabling from S2J3 to the R sampler A64J2 (refer to the overall block diagram).

If less than − 5 dBm at S2J3, the problem is in the A53 mixer/amp, A57 fixed oscillator, S2, or S3. Measure power at the A53 end of cable W6. If power is greater than +8 dBm, S3 is good; if not, replace S3. Measure power on the S2 end of W36. If the power is greater than −5 dBm, replace S2. If the power is less than − 5 dBm, the problem is the A53 mixer amp or the A57 fixed oscillator. Replace the A53 first and if the problem persists, replace the A57.

Mid Band: press [SYSTEM] SERVICE MENU SERVICE MODES SRC TUNE DAC NUM MID BAND [4] [0] [0] [0] [x1]. (SRC tune in the mid band is capable of tuning the instrument from about 2.4 − 5 GHz).

Referring to the overall block diagram, S2, S3, A58 M/D/S, or A55 YIG 1 are the components that may be at fault. Since the analyzer phase locked in lowband, all of the phase lock circuitry is working, so look for low power as a cause of phase lock errors. Check power at S2J3. If the power at S2J3 is less than 0 dBm, check the insertion loss of S3, S4 and the associated cabling. If the power at S2J3 is greater than 0 dBm, the problem is probably above 5 GHz. Check all RF cabling and connections, then replace the A55 YIG 1 first, then the A58 M/D/S.

High Band: press [SYSTEM] SERVICE MENU SERVICE MODES SRC TUNE DAC NUM HIGH BAND [4] [0] [0] [0] [x1]. (SRC TUNE in the high band is capable of tuning the instrument from about 19.5 – 24 GHz.)

Referring to the overall block diagram, S1, A55 YIG 2, or the A58 M/D/S are the components that may be at fault. Since the analyzer phase locked in low and/or mid band, all of the phase lock circuitry is probably working, so look for low power as a cause for phase lock errors. Check power at the output of S12. If the power is less than +5 dBm, check the insertion loss of S1 and the associated cabling. If the power out of S1 is greater than +5 dBm, the problem is probably above 24 GHz. Check all RF cabling and connections; then replace the A54 YIG 2 first, then the A58 M/D/S.

BROADBAND POWER PROBLEMS

This section assumes that a power problem exists across the full frequency range, but that no error message is displayed on the CRT. The problem may affect port 1 or port 2 or both. Suspect assemblies include:

A69 step attenuator	A59 source interface board	A63 directional coupler
S4 transfer switch	A58 M/D/S(if 8722A) A58 M/A/D/S(if 8722C)	A61 bias tee
A62 directional coupler	A60 bias tee	S1 switch

Perform power adjustments first.

To troubleshoot, press [MENU] CW FREQ [3] [G/n]. For port 2 problems also press [MEAS] Refl: REF S22.

ALC/Signal Separation Check

Disable the ALC by pressing [SYSTEM] SERVICE MENU ALC OFF to eliminate modulator control and measure the power at the faulty port:

- At least −3 dBm at the port: replace the A59 source interface board assembly.
- Less than −3 dBm at the port: press [MEAS] and Refl: REF S22 or Refl: FWD S11 and measure power at the second port:

- Less than −3 dBm at the second port: continue with *A69 Step Attenuator Check*, next.
- At least −3 dBm at the second port either the directional coupler or the bias tee or the transfer switch (S4) is faulty. The power loss through each of these components should be negligible.

A69 Step Attenuator Check

Measure the input and output power of the step attenuator; the loss should be negligible.

NOTE: if the 5 dB attenuation steps seem inconsistent in use, do this:

1. Reconnect the step attenuator to the transfer switch. Connect an open or short to port 1.
2. Press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU INPUT PORTS A [SCALE REF] REFERENCE POSITION [9] [x1] REFERENCE VALUE [−] [3] [0] [x1] to set up the instrument.
3. Press [MENU] POWER and then select range 2 through 10 consecutively to reduce the output power. The A channel trace on the display should step down about 5 dB with each range. If the steps are irregular or unrepeatable, replace the step attenuator. To repeat this step, reset the power to +15 dBm by pressing [MENU] POWER RANGE 2 [−] [1] [5] [x1].

A51 INTERFACE POWER SUPPLIES

Power is supplied to the lower box assemblies through ribbon cable W12 which connects to A51 at A51J1 (see location diagram on the instrument cover). Table 10−5 lists the supply voltages at A51J1, the assemblies that use these supplies, and the source of each supply for each assembly. Note that address and control lines are not shown.

Measuring Lower Box Bias Voltages

To check bias voltages, locate the suspected assembly and measure the voltages at the jack (J) and pin (p) noted.

- If the voltages are correct, return to the source troubleshooting procedure that referenced this step and continue.
- If any voltage is incorrect, disconnect cable W12 at A51J1 and measure the same voltage at the end of the cable (see the top row of Table 10−5 and Figure 10−5).
- If the W12 voltages are correct, A51 is faulty.
- If the W12 voltages are incorrect, refer to *A8 Test Point Voltages* (in *Power Supply*) to check these supplies and troubleshoot if necessary. If the supplies at A8 are correct, check cable W12 and traces on the A17 (upper box) motherboard.

Table 10–5. A51 Interface Power Supplies

Lower Box Assemblies	A51J1 Voltages				
	—15V	+5V	+15V	+23V	—5.2V
W12 cable	W12P1p21	W12P1p22	W12P1p23	W12P1p24	W12P1p25
A52 pulse generator	A51J4p2		A51J4p3		A51J4p4
A53 low band microcircuit			A51P1p17		
A54 YIG2	A51P1p10	A51P1p11		A51P1p18*	
A55 YIG1	A51P1p10	A51P1p11		A51P1p18*	
A56 lower front panel				A51J3p3	
A57 LO	A51P1p10			A51P1p18*	
A58 M/A/D/S			A51P1p17		A51P1p12
A64 R sampler	A51J11p3		A51J11p4		
A65 A sampler	A51J9p3		A51J9p4		
A66 B sampler	A51J10p3		A51J10p4		
A69 step attenuator				A51J2p6	

*Supply passes through other components and voltage may be lower.

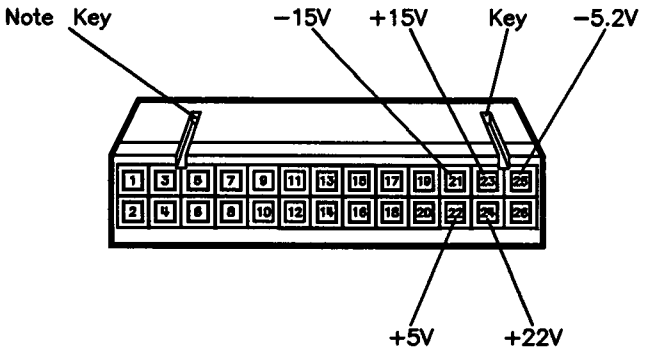


Figure 10–5. Voltages at Pins of W12P1

RECEIVER

Chapter 11. Receiver

INTRODUCTION

Use this section to determine which receiver assembly of the instrument is faulty. The two receiver assemblies that affect all three signal paths are the A10 digital IF and A12 reference assemblies. The receiver assemblies that are associated with specific signal paths are listed in Table 11−1.

Table 11−1. Receiver Assemblies and Associated Paths

Signal Path	Port	Directional Coupler	Sampler	2nd Converter
R	internal		A64	A6
A	1	A62	A65	A4
B	2	A63	A66	A5

START HERE

If all three signal paths showed unexpected results in the *Isolate Faulty Group* section, continue with *All Signal Paths Look Abnormal*.

If at least one signal path looked good, but the others did not, go to *At Least One Signal Path Looks Good*.

ALL SIGNAL PATHS LOOK ABNORMAL

For the receiver to operate properly, the A10 digital IF and 2nd converter assemblies must receive signals from the A12 assembly. Those signals are the 2nd LO and the 4 MHz signal.

2nd LO Check

Press [SYSTEM] SERVICE MENU INPUT PORTS ANALOG BUS [1] [6] [x1] COUNTER: ANALOG BUS to check the 2nd LO signal with the analog bus counter.

- Counter reads 9.996 MHz: continue with *4 MHz Check*.
- Counter does not read 9.996 MHz: perform the *A12 VCO Tune Adjustment*.
  - Successful adjustment, problem cured: perform the *Frequency Accuracy Performance Test* for verification.
  - Unsuccessful adjustment or problem persists: replace A12 assembly.

4 MHz Check

Use an oscilloscope to observe the 4 MHz signal at A10P2 pin 6 (either monitor the signal on the underside of the motherboard or use the extender board).

- 4 MHz sine wave signal at A10P2 pin 6: replace A10.
- 4 MHz sine wave signal not at A10P2 pin 6: check signal at A12P2 pin 36.
  - 4 MHz signal not at A12P2 pin 36: replace A12.
  - 4 MHz signal at A12 (but not A10): check the motherboard trace.

AT LEAST ONE SIGNAL PATH LOOKS NORMAL

One normal signal path indicates that at least one sampler, one 2nd converter, A12 and much of A10 are functional. Thus substitution is a convenient troubleshooting approach. If two signal paths are abnormal, repeat the steps of this section for each suspect signal path.

NOTE: to see the traces again, connect a short to port 1 to see signal path A or to port 2 to see signal path B. Then press [RECALL] RECALL FAC PRESET [SYSTEM] SERVICE MENU INPUT PORTS and R or A or B TEST SET REV .

If the R signal path trace is abnormal, the R sampler is nonetheless good (or there would be a phase lock problem): go directly to *2nd Converter Check*.

If the A or B signal path is very low (not just lossy, see Figure 11−1) and the R signal path is normal, go to *A and B Sampler Check by Substitution*.

If the A or B signal path appears slightly low, as in the shaded area of Figure 11−1, the problem is possibly a faulty directional coupler or, more probably, a lossy sampler. To isolate the fault, continue with *Directional Coupler Check*, next.

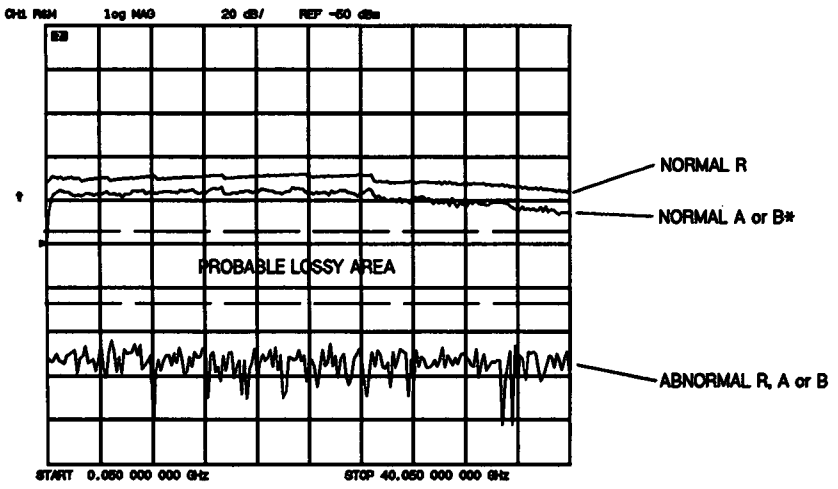


Figure 11–1. Normal and Abnormal Signal Path R, A and B Traces (Note scale and reference position)

Directional Coupler Check

To quickly check the directional coupler by elimination, set output power to −15 dBm by pressing [MENU] POWER RANGE 2 −25 to −15 .Connect the RF flexible cable from the tool kit from the output of the M/D/S directly to the J2 RF INPUT of the suspect signal path sampler. Press [SYSTEM] SERVICE MENU INPUT PORTS A or B and compare the trace to Figure 11–2.

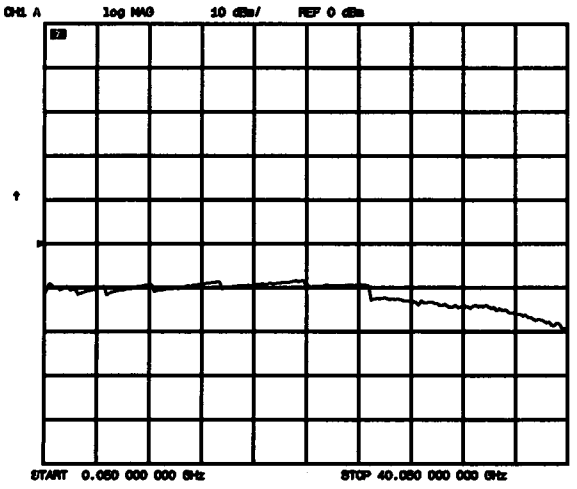


Figure 11–2. Directional Coupler Check CRT Trace

- Trace similar to Figure 11–2: the sampler is good, therefore the coupler is lossy. Replace the coupler.Minor power variations are probably due to the flexible cable and are of no concern.
- Trace abnormally low: the sampler is suspect, therefore the coupler is good. Troubleshoot the associated sampler by referring to *Sampler Voltage Check.*

A and B Sampler Check by Substitution

Set output power to −15 dBm by pressing [MENU] POWER RANGE 2 −25 to −15 . Connect the flexible cable from the tool kit from the output of the step attenuator A69 to J2 RF input of the suspect sampler. Connect the IF cable from A17J11 (or A17J12 if signal path B is faulty). Disregard the trace.

- Instrument phase locks (no error message): the sampler under test is normal. Go to *2nd Converter Check.*
- Instrument displays "PHASE LOCK CAL FAIL" error message: either the sampler or its control and bias voltages are faulty. Continue with *Sampler Voltage Check.*

Sampler Voltage Check

NOTE: The BIAS CONTROL line is not used.

Check the SAMPLER CONTROL voltage (green wire) at the suspect sampler. The voltage should be about +0.2V when the sampler is on. If the sampler control voltage is wrong, replace A51, the interface assembly. (Do NOT replace the sampler: the problem is in the control signals.)

Check the +15V and —15V supply voltages.

- If the supply voltages are within 5% of nominal, replace the sampler.
- If the supply voltages are incorrect, refer to *A51 Interface Power Supply* at the end of the *Source* troubleshooting section.

Restore the sampler cables to their normal positions.

2nd Converter Check

NOTE: repair signal path R before troubleshooting signal path A or B.

Faulty R Signal Path If R is the bad signal path, substitute A6 (R 2nd converter) with a 2nd converter from the working signal path. Press [SYSTEM] SERVICE MENU INPUT PORTS R and compare the CRT trace to the signal path R trace of Figure 11−1.

- Normal trace: replace the faulty 2nd converter.
- Abnormal trace: replace A10.

Faulty A or B Signal Path. If A is the bad signal path, remove A6 (the working R signal path 2nd converter) and install A4 (the suspect A signal path 2nd converter) in its place. If B is the bad signal path, substitute A6 with A5.

Press [SYSTEM] SERVICE MENU INPUT PORTS R and compare the CRT trace to the signal path R trace of Figure 11−1.

- Normal trace means the substitute 2nd converter functions: replace A10.
- Abnormal trace means the substitute is faulty: replace A4 (or A5).

Chapter 12. Accessories

INTRODUCTION

22AIn a broad sense, measurement failures can be divided into two categories:

- hard failures which impede the normal functioning of the analyzer or prohibit the use of a feature and,
- soft failures which don't affect the normal functioning of the analyzer but render incorrect measurement data.

The emphasis of this troubleshooting section is soft failures. Soft failures are usually caused by faulty calibration devices or connectors, bad cables, improper calibration techniques, or RF cabling problems within the analyzer.

At this time, the analyzer is assumed to be free of hard failures – it passed the previous checks provided in *Isolate Faulty Group*. Any remaining anomaly must be a soft failure. Use the following procedures to isolate the fault.

START HERE

Accessories troubleshooting is organized in three major sections. It is suggested that the procedures be performed in the order given:

1. Inspect and Gauge all Connectors: Check the physical condition of the test port connectors and calibration kit devices.
2. Switch Repeatability: Check the operation of the mechanical transfer switch.
3. Inspect Error Terms: Use the error terms to isolate faulty components and troubleshoot.

INSPECT AND GAUGE CONNECTORS

1. Inspect the test port connectors on the front panel of the analyzer. Check for bent or broken center pins and loose connector bulkheads.

   Gage both connectors. (Gages are part of the HP 85056B calibration kit.) The specified test port connector center pin **recession** is 0.0001 to 0.0005 inches. The center pin must be recessed.

   If the center pin recession is incorrect, replace the entire connector assembly (see *Disassembly and Replacement Procedures* and the figure labeled *Front Panel* in *Replaceable Parts*).

2. Inspect the calibration kit devices for bent or broken center conductors and other physical damage. Gauge each device. The mechanical specifications for each device are given in the calibration kit manual.

   If any calibration device is out of mechanical tolerance, replace the device.

SWITCH REPEATABILITY

Calibration does not compensate for the repeatability of the mechanical transfer switch, so the switch can be a source of error. To check the switch, use the following procedure:

1. Press [RECALL] RECALL FAC PRESET [AVG] IF BW [1] [0] [0] [x1] to set the bandwidth to 100 Hz.

2. Press [CAL] CALIBRATE MENU RESPONSE to access the response calibration menu.

Connect a short to test port 1 and press SHORT DONE:RESPONSE.

3. Press [DISPLAY] DATA → MEM DATA / MEM [SCALE REF] [.] [0] [1] [x1] to display data/ memory and scale the trace.

4. Press [MEAS] and then repeatedly (6 to 12 times) press S22 S11 to switch back and forth between S22 and S11 6 to 12 times. Return to the S11 measurement condition.

The trace should be within a 0.06 dB window around the 0 dB reference line (3 divisions in either direction).

5. Press [MEAS] S22 [DISPLAY] DATA to check the switch at port 2.

Repeat steps 2, 3 and 4, only this time monitor the S22 trace for the 0.06 dB window.

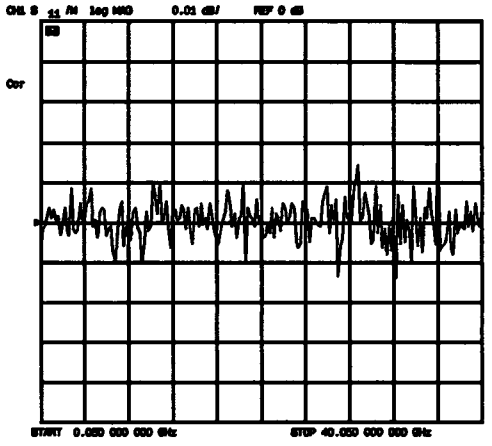


Figure 12–1. Typical Switch Repeatability Trace

INSPECT ERROR TERMS

Error terms are basically a measure of a "system": a network analyzer and calibration kit and any cables used. As required, refer to the *Error Terms* troubleshooting section for:

- The specific measurement calibration procedure used to generate the error terms,
- The routines required to extract error terms from the instrument, and
- Typical error term data.

Use Table 12–1 to cross–reference error term data to system faults.

Table 12–1. Components Related to Specific Error Terms

Component	Directivity	Source Match	Refl't'n Tracking	Isolation	Load Match	Transmission Tracking
cal kit load	x					
cal kit/open/short		x	x			
test port conn	x	x	x	x	x	x
coupler	x	x	x	x	x	x
bias tee		x	x	x	x	x
transfer switch		x	x	x	x	x
step attenuator		x	x		x	x
sampler			x	4*		x
A10 digital IF				x		
external cables					x	x

*Frequency, in GHz, at which the component is more likely to contribute to crosstalk.

If problems are detected using error term analysis, use the following approach to isolate the fault:

1. Check the cable by examining the load match and transmission tracking terms. If those terms look suspicious, go to *Cable Test*.

2. Verify the cal kit devices:

   Loads: If the directivity error term looks good, the load and the port are good. If directivity looks bad, connect the same load on the other port and measure its directivity. If the second port looks bad, as if the problem had shifted with the load, replace the load. If the second port looks good, as if the load had not been the problem, troubleshoot the first port by continuing with *Isolate the Fault in the RF Path*.

   Shorts and opens: If the source match and reflection tracking terms look good, the shorts and the opens are good. If these terms look bad while the rest of the terms look good, proceed to *Verify Shorts and Opens*. If other error terms also indicate a problem, proceed with *Isolate the Fault in the RF Path*.

Isolate the Fault in the RF Path

Since the calibration devices have been verified, the problem exists in the test port connector, the coupler, or elsewhere in the internal RF path. Table 12−1 shows which assemblies affect each error term. If more than one error term is bad, note which assemblies are common to each of the bad terms. These are the suspects.

There are two methods of fault isolation. The simpler of the two methods can be used only with option 010 (time domain) instruments. (To check, press [SYSTEM]. If the middle softkey is labeled TRANSFORM MENU, the instrument has option 010.)

Continue with *Time Domain Fault Isolation*, next, if possible, or go to *Assembly Substitution Fault Isolation*, following.

Time Domain Fault Isolation. Connect a short to the port that exhibits the problem. Press [RECALL] RECALL FAC PRESET. Make sure you are driving the problem port: press [MEAS] S22 to troubleshoot port 2.

Press [SYSTEM] TRANSFORM MENU TRANSFORM ON [FORMAT] LIN MAG [MENU] NUMBER of POINTS [4] [0] [1] [x1] [SCALE REF] [1] [0] [k/m] [STOP] [START] [0] [x1] [1] [0] [G/n] to turn on time domain and scale the display.

The CRT should show a trace similar to Figure 12−2, typical plots of the analyzer's RF path. The traces show reflections starting at the port's connector, continuing back into the instrument. Each spike in the trace represents a discontinuity or mismatch in the system. These usually occur at connections between assemblies and cables or at bends in the cables.

Significant mismatches will be obvious.

Mismatches which cause the instrument to generate unusual error terms or fail system verification will be obvious on the linear magnitude scale. Such mismatches will go offscale, as the short does. Some variation from port to port and instrument to instrument is normal. Minor mismatches are inherent in the construction of the instrument. Refer to Figure 12−2 and use the minor mismatches as markers to identify specific areas of the instrument.

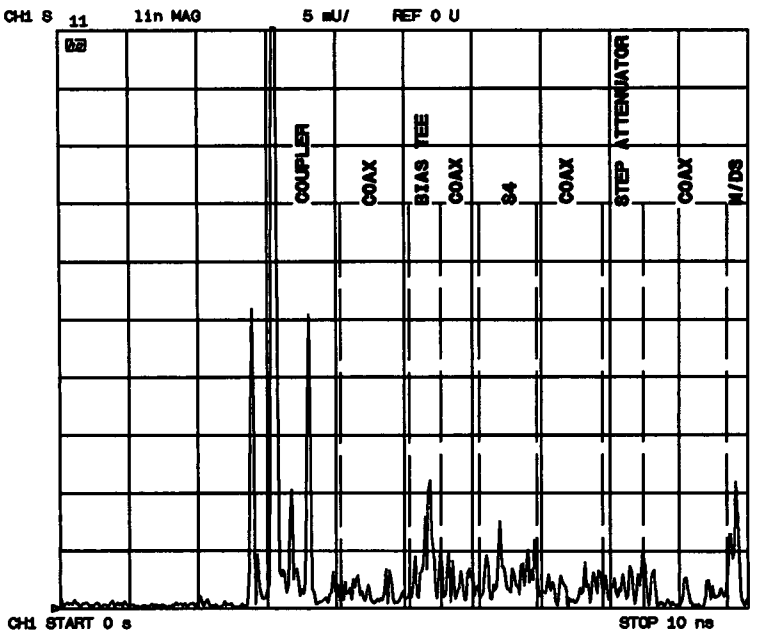


Figure 12–2. Typical Time Domain Plot of Internal RF Path

NOTE: Hewlett–Packard does not provide specifications for the individual assemblies internal to the analyzer. Therefore, the figures used within this section are intended as a guideline only. The only specifications warranted by Hewlett–Packard are those listed in the *Specifications* Section.

Assembly Substitution Fault Isolation At this point, the error term problem has been isolated to a specific port and you should have a list of suspected assemblies. Since the analyzer has two identical ports, you can swap identical assemblies between the port 1 and port 2 signal paths and then regenerate the error terms. When the problem moves from one port to another, you have found the offending assembly.

Before trying this, be sure to inspect the front panel test port connector for obvious damage. Tighten all semi–rigid cable connectors inside the instrument.

Cable Test

The load match error term is a good indicator of cable problems. Further verification of cable faults can be achieved by measuring the reflection of the cable. Perform an S11 1-port calibration directly at port 1 (no cables). Then connect the suspect cable to port 1 and terminate the open end in 50 ohms.

Figure 12-3 shows the return loss trace of a good (left side) and poor cable. Note that the important characteristic of a cable trace is its level (the good cable trace is much lower) not its regularity. Refer to the cable manual for return loss specifications.

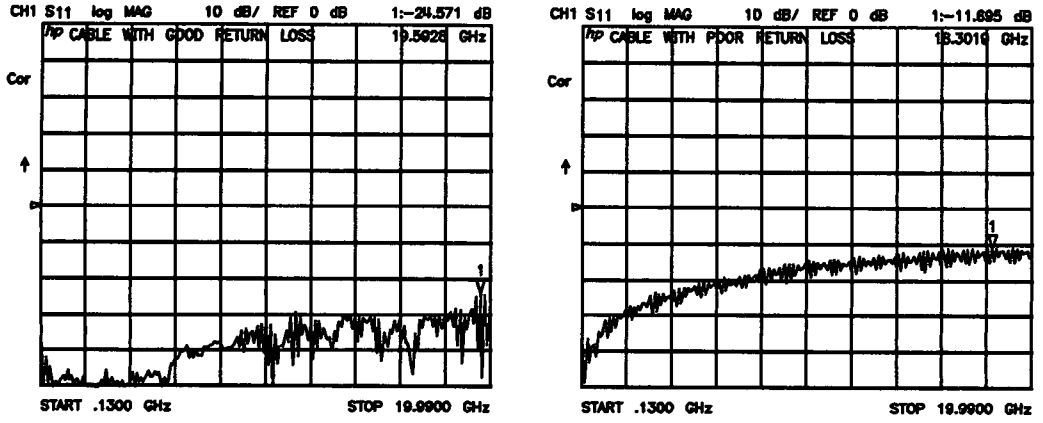

CH1 S11 log MAG 10 dB/ REF 0 dB 1:-24.571 dB
hp CABLE WITH GOOD RETURN LOSS 19.5928 GHz
Cor
START .1300 GHz STOP 19.9900 GHz
CH1 S11 log MAG 10 dB/ REF 0 dB 1:-11.695 dB
hp CABLE WITH POOR RETURN LOSS 18.3016 GHz
Cor
START .1300 GHz STOP 19.9900 GHz

Figure 12-3. Typical Return Loss Traces of Good and Poor Cables

Verify Shorts and Opens

Substitute a known good short and open of the same connector type and sex as the short and open in question. If the devices are not from one of the standard calibration kits, refer to *Modifying Calibration Kits* in Chapter 6 of the *Reference* to use the MODIFY CAL KIT function. Set aside the short and open that are causing the problem.

1. Perform an S11 1-port calibration using the good short and open. Then press FORMAT SMITH CHART to view the devices in Smith chart format.

2. Connect the good short to port 1. Press SCALE REF ELECTRICAL DELAY and turn the RPG to enter enough electrical delay so that the trace appears as a dot at the left side of the circle.

3. Replace the good short with the questionable short at port 1. If the trace of the questionable short does not appear very similar to the known good short, the questionable short is not suitable for use with the analyzer.

4. Connect the good open to port 1. Press SCALE REF ELECTRICAL DELAY and turn the RPG to enter enough electrical delay so that the trace appears as a dot at the right side of the circle (see Figure 12–4, right).

5. Replace the good open with the questionable open at port 1. If the trace of the questionable open does not appear very similar to the known good open, the questionable open is not suitable for use with the analyzer.

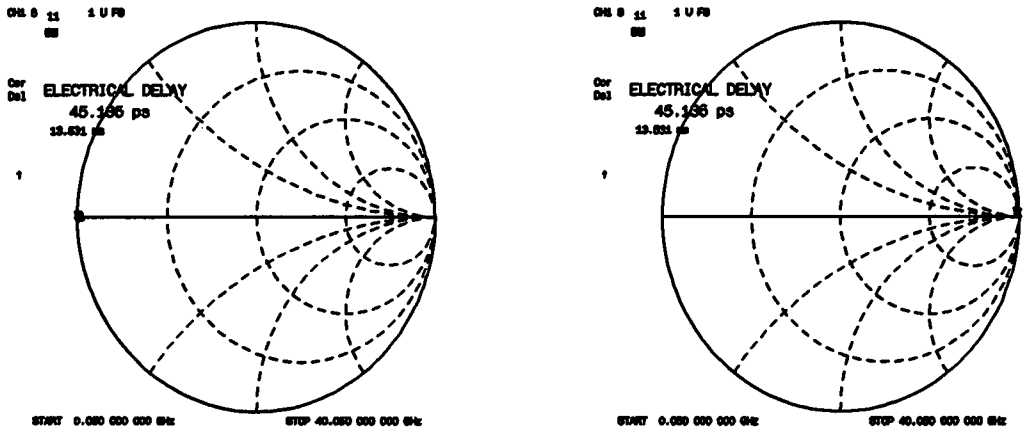


Figure 12–4. Typical Smith Chart Traces of Good Short (left) and Open

SERVICE KEY MENUS

Chapter 13. Service Key Menus

INTRODUCTION

This section describes the functions of the service key menus. These menus are used to test, verify, adjust, control and troubleshoot the instrument. They are divided into two groups: internal diagnostics and service modes. When applicable, the HP-IB mnemonic is written in parentheses following the key. See *HP-IB Mnemonic Definitions* at the end of this section.

INTERNAL DIAGNOSTICS SUMMARY

The internal diagnostics menus are shown in Figure 13-1 and described in the following paragraphs. The internal diagnostics keys are TESTS , TEST OPTIONS and SELF-DIAGNOSE .

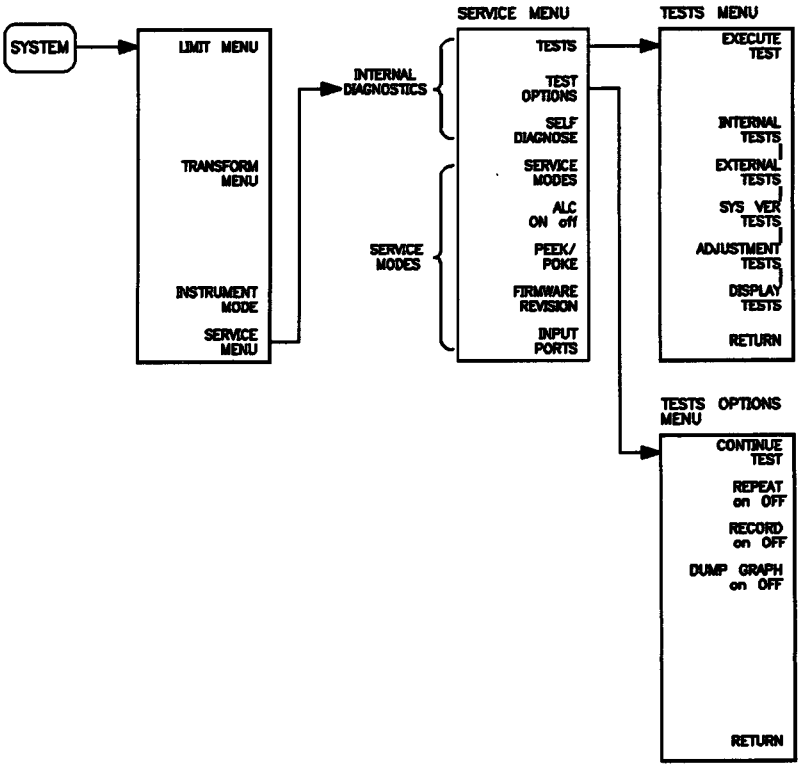


Figure 13–1. Internal Diagnostics Menus
(See Figure 13–2 for Service Modes Menus.)

TESTS MENU

TESTS (TEST[D]). This softkey makes TEST the active function and accesses a menu that can be used to select or execute tests 0 through 76 (default = 1). Remember, HP–IB commands appear in parentheses following the keystroke: **KEYSTROKE A** (COMMAND A).

The tests are divided by function into the categories, described below. To access the first test in each category, press the category softkey. To access the other tests, use the number pad, step keys or knob. The test number, name, and status abbreviation will be displayed in the active entry area of the CRT.

Table 13–1 shows the test status abbreviation that appears on the CRT, its definition, and the equivalent HP–IB code. The HP–IB command to output the test status of the most recently executed test is OUTPTESS. Refer to *HP–IB Service Mnemonic Definitions* at the end of this section for more information.

Table 13–1. Test Status Terms

CRT Abbreviation	Definition	HP–IB Code
PASS	PASS	0
FAIL	FAIL	1
—IP—	IN PROGRESS	2
(NA)	NOT AVAILABLE	3
—ND—	NOT DONE	4
DONE	DONE	5

EXECUTE TEST (EXET). This runs the selected test and may display these softkeys:

CONTINUE (TESR1) continues the selected test.

YES (TESR2) alters correction constants during adjustment tests.

NEXT (TESR4) displays the next choice.

SELECT (TESR6) chooses the option indicated.

ABORT (TESR8) terminates the test and returns to the tests menu.

NOTE: Descriptions of tests in each of the next four categories are given under the heading *Test Descriptions* in the following pages.

INTERNAL TESTS. These tests are completely internal and self–evaluating. They do not require external connections or user interaction.

EXTERNAL TESTS. These are additional self–evaluating self–tests. However, these require some user interaction (such as keystrokes).

SYS VER TESTS. These tests are part of the system verification procedure, and are also used to examine the contents of the measurement calibration arrays. The procedure is in the *Verification* section. Information about the calibration arrays is provided in the *Error Terms* section.

ADJUSTMENT TESTS. These tests generate and store the correction constants; refer to *Adjustments*.

DISPLAY TESTS. These tests check the display and GSP assembly.

TEST OPTIONS MENU

TEST OPTIONS accesses softkeys that affect the way tests (routines) run, or supply necessary additional data.

CONTINUE TEST (TESR1). This restarts the test where it was stopped.

REPEAT on OFF (TO2). This toggles the repeat function on and off. When ON, the selected test will run 10,000 times unless stopped by pressing any key. The current number of passes and fails is displayed on the CRT.

RECORD on OFF (TO1). This toggles the record function on and off. When ON, certain test results are sent to a printer via HP–IB. This is especially useful for correction constants. (Refer to Chapter 8 of the *Reference.*)

DUMP GRAPH on OFF When on during system verification, will cause graphs of verification results to be printed.

SELF DIAGNOSE SOFTKEY

SELF–DIAGNOSE examines in order the pass/fail status of all internal tests and displays "NO FAIL FOUND" if no tests have failed.

If a failure is detected, the routine displays the assembly or assemblies most probably faulty and assigns a failure probability factor to each assembly.

TEST DESCRIPTIONS

The analyzer has over 50 internal test routines that test, verify, and adjust the instrument. This section describes those tests.

Internal Tests

This group of tests runs without external connections or operator interaction. All return a PASS or FAIL condition. All run on power–up and PRESET except as noted.

0 **ALL INT.** This runs only when selected. It is the following subset of internal tests: first, the ROM tests 3 and 4; then tests 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, and 20. If any of these tests fail, this test displays a FAIL status. Use the RPG knob to scroll through the tests and see which failed. If *all* pass, the test displays a PASS status. Each test in the subset retains its own test status.

1 **PRESET.** This runs the following subset of internal tests: first, the ROM/RAM tests 2, 3, and 4; then tests 5, 6, 7, 8, 9, 10, 11, 14, 15, and 16. If any of these tests fail, this test returns a FAIL status. Use the RPG knob to scroll through the tests and see which failed. If *all* pass, this test displays a PASS status. Each test in the subset retains its own test status. This same subset is available over HP–IB as "TST?". It is not performed upon remote preset.

2 **ROM.** This test is part of the ROM/RAM tests and cannot be run separately. Refer to the *Digital Control* troubleshooting section for more information. If there is no FAIL message after preset or power–on, the test has passed.

3 **CMOS RAM**. Part of the ROM/RAM tests, this test verifies the A9 CPU CMOS (long–term) memory with a non–destructive write/read pattern that does not erase data. If a FAIL message is not displayed, the test has passed. A destructive version that writes over stored data is documented in *ROM/RAM Tests* at the end of this section.

4 **Main DRAM**. Part of the ROM/RAM tests, this verifies the A9 CPU main memory (DRAM) with a non–destructive write/read test pattern. If a FAIL message is not displayed, the test has passed. A destructive version is documented in *ROM/RAM Tests* at the end of this section.

5 **DSP Wr/Rd**. This verifies the ability of the main processor and the digital signal processor (DSP), both on the A9 CPU assembly, to communicate with each other through DRAM. Verifies that programs can be loaded to the DSP. Verifies most of the main RAM access circuits.

6 **DSP RAM**. This verifies the A9 CPU RAM associated with the digital signal processor by using a write/read pattern.

7 **DSP ALU.** This verifies the A9 CPU high–speed math processing portions of the digital signal processor.

8 **DSP Intrpt**. This tests the ability of the A9 CPU digital signal processor to respond to interrupts from the the A10 digital IF ADC.

9 **DIF Control**. This tests the ability of the A9 CPU main processor to write/read to the control latches on the A10 digital IF.

10 **DIF Counter**. This tests the ability of the A9 CPU main processor to write/read to the triple divider on the A10 CPU. It primarily tests the A9 CPU data buffers and A10 digital IF, but it also requires the 4 MHz clock from the A12 reference to pass.

11 **DSP Control**. This tests the ability of the A9 CPU digital signal processor to write to the control latches on the A10 digital IF. Feedback is verified by the main processor. It primarily tests the A10 digital IF, but failures may be caused by the A9 CPU.

12 **Fr Pan Wr/Rd**. This runs only when selected, and tests the ability of the A9 CPU main processor to write/read to the front panel processor. It primarily tests the A2 front panel interface and processor, with interrupts, but also requires A9 CPU data buffering and address decoding. (See also tests 23 and 24 below.)

13 **Rear Panel**. This runs only when selected or with ALL INTERNAL. It tests the ability of the A9 CPU main processor to write/read to the rear panel control elements. It mostly tests the A16 rear panel, but also requires A9 CPU data buffering and address decoding. (It does *not* test the HP–IB interface; for that see the *Introductory Operating Guide.*)

14 **Post Reg**. This polls the status register of the A8 post–regulator, and flags the following conditions: heat sink too hot, inadequate air flow, or post–regulated supply shutdown.

15 **Frac N Cont**. This tests the ability of the A9 CPU main processor to write/read to the control element on the A14 fractional–N (digital) assembly. The control element must be functioning, and the fractional–N VCO must be oscillating (although not necessarily phase–locked) to pass.

16 **Sweep Trig**. This tests the sweep trigger (L SWP) line from the A14 fractional−N to the A10 digital IF. L SWP synchronizes the receiver with the sweep.

17 **ADC Lin**. This runs only when selected, and tests the linearity of the A10 digital IF ADC using the built−in ramp generator. The test generates a histogram of the ADC linearity, where each data point represents the relative "width" of a particular ADC code. Ideally, all codes have the same width; different widths correspond to non−linearities.

18 **ADC Ofs**. This runs only when selected, and tests the ability of the offset DAC ont he A10 digital IF to apply a bias offset to the IF signals before the ADC input. Primarily tests the A10 digital IF.

19 **ABUS Test**. This runs only when selected, and measures several analog bus reference voltages (all nodes from the A10 digital IF) to test analog bus accuracy. It primarily tests the A10 digital IF.

20 **FN Count**. This test uses the internal counter to count the A14 fractional−N VCO frequency (120 to 240 MHz) and the divided fractional−N frequency (100 kHz). It requires the 100 kHz signal from A12 and the counter gate signal from A10 to pass.

External Tests

These tests require either external equipment and connections or operator interaction of some kind to run. Tests 23 and 24 are comprehensive front panel checks, more complete than test 12, that check the front panel keys and knob.

21 **Op Ck Port 1.** This test and the next are used in the Operator's Check procedure, documented in the *Verification* section of this manual. It requires the external connection of a short, and tests port 1 and the phase lock system.

22 **Op Ck Port 2**. Same as 21, but port 2.

23 **Fr Pan Seq**. This tests the RPG and all A1 front panel keys, as well as the front panel microprocessor on the A2 assembly. It prompts the user to rotate the RPG, then press each key in an ordered sequence. It continues to the next prompt only if the current prompt is correctly satisfied.

24 **Fr Pan Diag**. Similar to 23 above, but the user rotates the RPG or presses the keys in any order, and this test displays the command the instrument received.

25 **ADC Hist**. Factory use only.

Sys Ver Tests

These tests apply mainly to system−level, error−corrected verification and troubleshooting. Tests 26 to 30 are associated with the system verification procedure, documented in the *Verification* section. Tests 31 to 42 facilitate examining the calibration coefficient arrays (error terms) resulting from a measurement calibration; refer to the *Error Terms* section for details.

26 **Sys Ver Init**. This recalls the initialization state for system verification from disc, in preparation for a measurement calibration. It must be done *before* 27, 28, 29, or 30 are performed.

27 **Ver Dev 1**. This recalls verification limits from disc for verification device #1 in all applicable S–parameter measurements. It performs pass/fail limit testing of the current measurement.

28 **Ver Dev 2**. Same as 27 above for device #2.

29 **Ver Dev 3**. Same as 27 above for device #3.

30 **Ver Dev 4**. Same as 27 above for device #4.

31–42 **Cal Coef 1–12**. These tests copy error term data from a measurement calibration array to display memory. A measurement calibration must be complete and correction must be on. Definition of calibration arrays depends on the current calibration type. After execution, memory is automatically displayed. Formatting, markers, and graphics function normally. Refer to the *Error Term* section for details.

Adjustment Tests

These tests are used in the *Adjustments* section of this manual.

43 **Pretune Adj.** This generates two correction constants for use in establishing phase–lock.

44 **ABUS Cor**. This measures three fixed voltages on the ABUS, and generates new correction constants for ABUS amplitude accuracy in both high resolution and low resolution modes.

45 **Intensity Cor**. This stores the current values of the adjustments made in the Display Intensity Adjustments.

46 **Disp 2 Ex**. This displays a rainbow of 15 colors plus white, ranging from pure red (0) to green (33) to blue (67) and beyond. Press softkey 8 (bottom) to exit.

47 **IF Step Cor**. This measures the gain of the IF amplifiers (A and B only) located on the A10 digital IF, to determine the correction constants for absolute amplitude accuracy. It provides smooth dynamic accuracy and absolute amplitude accuracy in the —30 dBm input power region.

48 **ADC Ofs Cor**. This measures the ADC linearity characteristics, using an internal ramp generator, and stores values for the optimal operating region. During measurement, the receiver adds an offset bias to the IF signals so they are centered in the optimal region. This improves low–level dynamic accuracy.

49 **Serial Cor**. This stores the serial number (input by the user in the display title menu) in EEPROM. Note that this routine will not overwrite an existing serial number.

50 **Option Cor**. This stores the option registration number (required for option 001 or 010 or both).

51 **Cal Kit Def.** This loads the default calibration kit definitions (device model coefficients) into EEPROM.

52 **Power Adj.** Measures power linearity at the test port. Generates correction constants to improve power linearity.

53 **Init EEPROM.** Factory use only

54 **Blanking Adj.** Allows adjustment of power out during retrace.

Display Tests

The tests do *not* signal a PASS/FAIL condition on the CRT; the CRT will be blank or dim. Instead, the six upper front panel LEDs indicate the PASS/FAIL status:

All six LEDs OFF: PASS.

Any LED ON: FAIL.

Press [PRESET] to exit the test.

55 **Disp/cpu com.** This checks the CPU's capability to communicate with the A19 GSP assembly.

56 **DRAM cell.** This tests the DRAM on A19.

57 **Main VRAM.** This tests the VRAM on A19.

58 **VRAM bank.** The GSP tests all the cells in each of the 4 VRAM banks.

59 **VRAM/video.** This test verifies that the A19 GSP can write and read shift register transfers. It also checks the video signals LHSYNC, LVSYNC, and LBLANK to verify that they are active and toggling.

60 **RGB outputs.** This test confirms that the analog video signals are correct and functional.

61 **Inten DAC.** This verifies that the intensity DAC can be set low and high.

Test Patterns

Test patterns, with one exception, are for factory only. Test patterns are displayed by entering the test number [x1] EXECUTE TEST CONTINUE. The test pattern will be displayed and the softkey labels blanked.

To exit, press softkey 8 (bottom).

NOTE: In all solid test patterns, an extremely thin full-screen horizontal line is visible about 1/4 screen height from the bottom. This condition is characteristic of the CRT does not indicate any problem.

62 **Test pat 1.** This all white pattern is used to verify the light output of the A18 display and to check for color purity.

63-65 **Test Pat 2-4.** These all Red, Green, and Blue patterns show the color purity of the CRT and its capability to independently control each gun color. In case of problems, refer to the "HP 8719A/20B Display Degaussing (Demagnetizing)" procedure in the "Adjustments" section.

66 **Test Pat 5.** This is a 16–step gray scale pattern.

67 **Test Pat 6.** This 3–step gray scale pattern is used in the "Background Adjustment" of the display.

68 **Test Pat 7.** This convergence pattern is for factory use only.

69–70 **Test Pat 8–9.** These crosshatch and inverse crosshatch patterns are for factory use only.

71 **Test Pat 10.** This H pattern is for factory use only.

72 **Test Pat 11.** This normally solid white pattern checks the pixel stretching circuit of the A19 GSP assembly. Sixteen alternating white and gray vertical stripes indicate problems with the STRETCH line and LFIRSTPIX.

73 **Test Pat 12.** This repeating gray scale pattern is for factory use only.

74 **Test Pat 13.** This color rainbow pattern is the same as test 46.

75 **Test Pat 14.** This character set represents the different types and sizes of characters available. Control characters are not displayed.

76 **Test Pat 15.** This bandwidth pattern provides a quick visual verification of the bandwidth of the display. It consists of multiple alternating white and black vertical stripes. Each stripe should be clearly visible. A limited bandwidth would smear these lines together. No field adjustment is possible.

SERVICE MODES SUMMARY

The service modes menus are shown in Figure 13–2 and described in the following paragraphs. The service modes softkeys are SERVICE MODES ALC ON off PEEK/POKE FIRMWARE REVISION and INPUT PORTS.

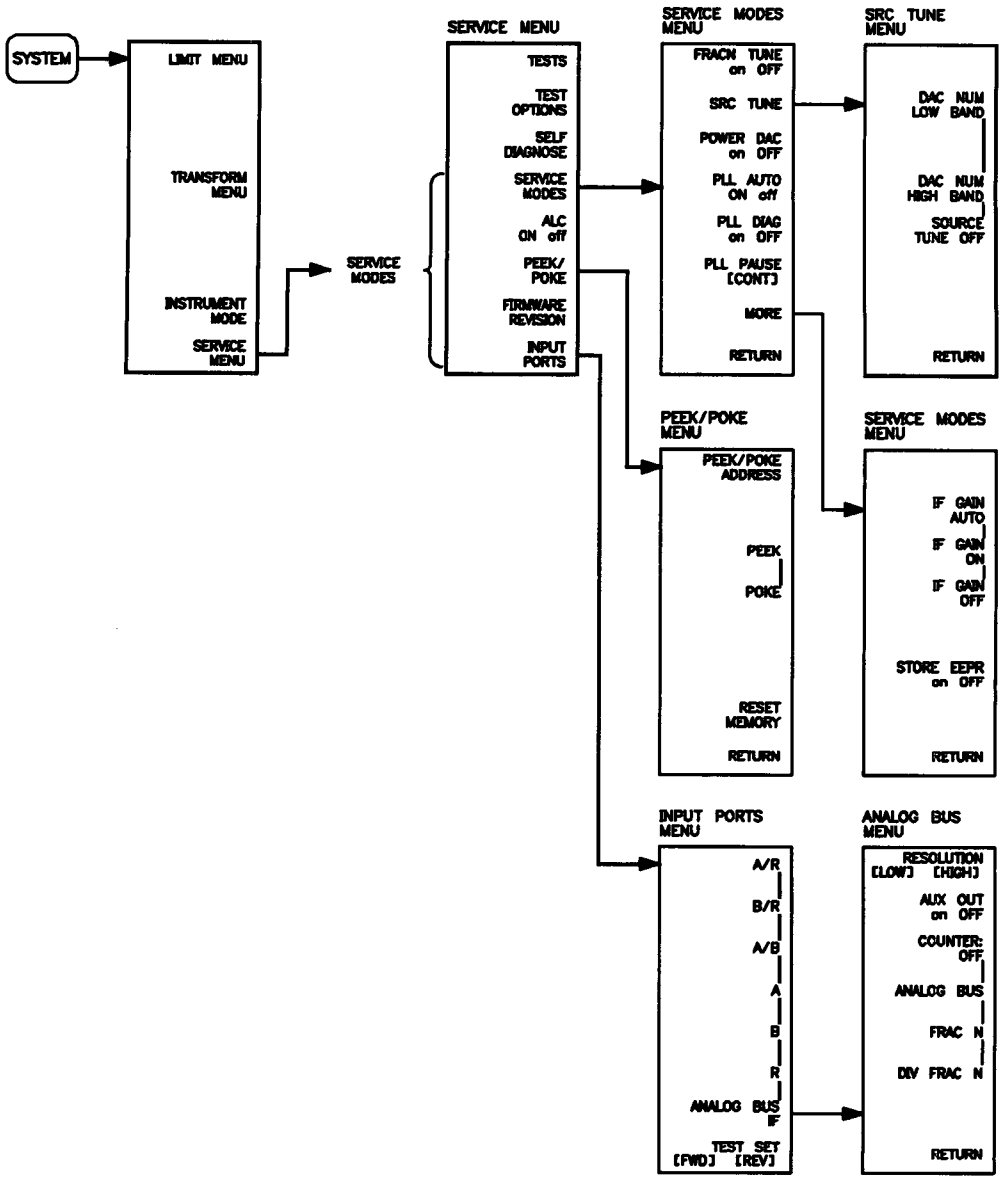


Figure 13–2. Service Modes Menus

SERVICE MODES MENU

This menu accesses other menus and softkeys that allow you to control and monitor various circuits for troubleshooting. To access the service modes menu, press [SYSTEM] SERVICE MENU SERVICE MODES (see Figure 13–2).

FRACN TUNE on OFF (SM1<on|off>). This mode is useful for testing the A13 and A14 fractional–N circuits. It allows you to directly control and monitor the output frequency of the fractional–N VCO (60 MHz to 240 MHz).

The front panel keys or knob can be used to enter the frequencies of interest. The output of the A14 assembly can be checked at A14TP1 (VCO/2) with an oscilloscope, a frequency counter, or a spectrum analyzer. The frequency is one–eighth the VCO frequency generated on the A14 assembly.

SRC TUNE (SM2E). Use this mode to test the pretune functions of the phase lock and source assemblies. See *SRC Tune Menu*, following.

POWER DAC on OFF (SM3 <on/off>). Allows variation of test port power by setting power control DAC.

PLL AUTO ON off (SM4<on|off>). During normal operation (PLL AUTO ON) when the instrument encounters phase lock problems (e.g. "harmonic skip"), it will automatically attempt to determine new pretune values. It will continue to do this until phase lock is achieved. This mode allows you to disable that function so that the phase–locked loop is not continuously trying to recalibrate itself. With PLL AUTO OFF the frequencies and voltages are not changing as they are when they are attempting to phase lock, so troubleshooting the phase–locked loop circuits is more convenient.

PLL DIAG on OFF (SM5<on|off>). The instrument starts a new phase lock sequence at the beginning of each sweep. This normally occurs very rapidly, making it difficult to troubleshoot phase lock problems. Turning this mode ON slows the process down, allowing you to inspect the steps of the phase lock sequence (pretune, acquire, and track) by pausing at each step. The steps are indicated on the CRT, along with the channel (C1 or C2) and band number (B2 through B11).

This mode can be used with PLL PAUSE to halt the process at any step. It can also be used with the analog bus counter.

PLL PAUSE. This mode is used only with PLL DIAG mode. CONT indicates that it will continuously cycle through all steps of the phase lock sequence. PAUSE holds it at any step of interest. This mode is useful for troubleshooting phase–locked loop problems.

MORE. This accesses the service modes more menu listed below.

SERVICE MODES MORE MENU

IF GAIN AUTO . This mode is the normal operating condition and works in conjunction with IF GAIN ON and OFF. The A10 assembly includes a switchable attenuator section and an amplifier that amplifies low–level 4 kHz IF signals (for A and B inputs only). This mode allows the A10 IF section to automatically determine if the attenuator should be switched in or out. The switch occurs when the A or B input signal is approximately —30 dBm.

IF GAIN ON . This mode locks out the A10 IF attenuator sections, regardless of the amplitude of the A or B IF signal. Be aware that input signal levels above —30 dBm at the sampler input will saturate the ADC and cause measurement errors. Turning this ON switches out both the A and B attenuation circuits; they cannot be switched independently. This mode is useful for checking the A10 IF gain amplifier circuits.

IF GAIN OFF . This mode forces the A10 IF gain attenuators to be switched in, regardless of the amplitude of the A or B IF signal. It is important to note that small input signals will appear noisy, and raise the apparent noise floor of the instrument. Turning this OFF switches both the A and B gain amplifier circuits; they cannot be switched independently. This mode is useful for checking the A10 IF gain amplifier circuits.

STORE EEPR on OFF . This mode allows you to store the correction constants that reside in non–volatile memory (EEPROM) onto a disc. Correction constants improve instrument performance by compensating for specific operating variations due to hardware limitations (refer to the *Adjustments* section). Having this information on disc is useful as a backup, in case the constants are lost (perhaps due to a CPU board failure). Without a disc backup the correction constants can be regenerated manually, although the procedures are more time consuming.

SRC TUNE MENU

This mode is useful for testing the pretune functions of the phase lock and source assemblies. Press [SYSTEM] **SERVICE MENU** **SRC TUNE** to access the menu (shown in Figure 13–2.)

NOTE: If the instrument displays the "Phase Lock Cal Failure" message, use the **DAC NUM xxx BAND** keys below. The relationship between DAC numbers and frequency varies from instrument to instrument. The DAC numbers below are guidelines only.

DAC NUM LOW BAND (SM2L). Allows entry of digital data directly into the DAC on the A11 phase lock assembly. Use the front panel keys, knob or step arrows to enter DAC numbers in the range of 3650 through 4095 to generate frequencies from 50 MHz to 1.1 GHz.

DAC NUM HIGH BAND (SM2H). As above but for DAC numbers 3000 to 4095; frequency range 2.3 GHz to 4.9 GHz.

SOURCE TUNE OFF (SM2D). This key disables the source freq tune modes.

ALC ON OFF SOFTKEY

ALC ON off (ALC <ON|OFF>). This toggles the ALC circuit on and off. When off, the ALC voltage to the modulator is held at a constant level; this gives an "open–loop" condition with maximum output power.. Use ALC OFF to troubleshoot source power problems.

PEEK/POKE MENU

The PEEK/POKE softkey displays a menu that allows you to access different memory locations and view or change the contents. Access the menu by pressing SYSTEM SERVICE MENU PEEK/POKE as shown in Figure 13–2. The keys are described below.

CAUTION: PEEK/POKE capability is intended for service use only.

PEEK/POKE ADDRESS (PEEL[D]). This softkey accesses any memory address and displays it in the active entry area of the CRT. Use the RPG, entry keys, or step keys to enter the memory address of interest.

PEEK (PEEK). This softkey displays the data at the memory address accessed by pressing PEEK/POKE ADDRESS.

POKE (POKE[D]). This softkey allows you to change the data at the memory address accessed by the PEEK/POKE ADDRESS softkey. Use the RPG, entry keys, or step keys to change the data.

RESET MEMORY. This softkey allows you to reset or clear the memory where instrument states are stored. To do this, press RESET MEMORY PRESET.

FIRMWARE REVISION SOFTKEY

Press FIRMWARE REVISION (following SYSTEM SERVICE MENU, see Figure 13–2) to display the current firmware revision information. The number and implementation date appear in the active entry area of the CRT as shown in Figure 13–3 on page 13–14. Another way to display the firmware revision information is to cycle power.

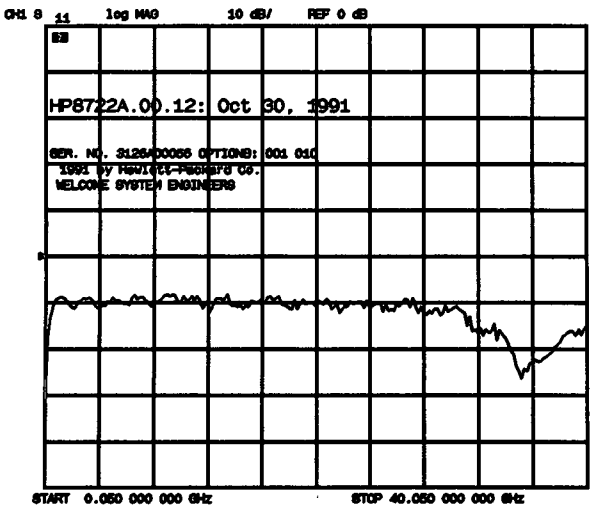


Figure 13–3. Location of Firmware Revision Information on CRT

INPUT PORTS MENU

This menu allows the user to display any one of four input signals on the active channel and drive either front panel port. The input ports, A, B, R and analog bus, are explained below.

A . Displays the A input signal without dividing by the reference; useful for troubleshooting components in the A input path.

B . Same as **A** , above, but for B.

R . Displays the R input signal alone; useful for troubleshooting components in the R input path.

A/R Displays A input signal divided by the reference.

B/R Displays B input signal divided by the reference.

A/B Displays A input signal divided by the B input signal.

ANALOG BUS (ANAB<ON|OFF>). This key displays the current analog bus input (which can be one of 23 nodes throughout the instrument). It also accesses the analog bus menu, described below. For a description of the capabilities of the analog bus and the location of its nodes, refer to *Description of the Analog Bus*, below.

TEST SET [FWD] . This toggles between FWD to drive port 1 and REV to drive port 2. Press this key to exercise the transfer switch S4 or check the operation of port 2. This key does not function if **ANALOG BUS** , above, has been selected.

ANALOG BUS MENU

This menu lets the user select and monitor voltage and frequency nodes with the analog bus and internal counter as shown in Figure 13–2 and explained below.

RESOLUTION [LOW] . This toggles between low and high **RESOLUTION**. Use low resolution for large voltages (between +10 and —10 volts). Use high resolution to measure small voltages (less than 0.5 volts, positive or negative).

AUX OUT on OFF . This allows you to monitor the analyzer's analog bus nodes (except nodes 1 through 4) with external equipment (oscilloscope, voltmeter, etc.). To do this, connect the equipment to the AUX INPUT BNC connector on the rear panel, and press **AUX OUT** .

CAUTION

NEVER input any signal to the AUX INPUT rear panel connector with this function turned ON. Doing so can cause damage to the instrument.

COUNTER: OFF . This switches the internal counter off and removes the counter display from the CRT. The counter can be turned on with one of the next three keys. (Note: Using the counter slows the sweep.) The counter bandwidth is 16 MHz unless otherwise noted for a specific node.

NOTE: OUTPCNTR is the HP–IB command to output the counter's frequency data.

ANALOG BUS . This switches the counter to count the analog bus.

FRAC N . This switches the counter to count the A14 fractional–N VCO frequency at the node shown on the *Overall Block Diagram*.

DIV FRAC N . This switches the counter to count the A14 fractional–N VCO frequency after it has been divided down to 100 kHz for phase locking the VCO.

DESCRIPTION OF THE ANALOG BUS

The analog bus is a single multiplexed line that networks 23 nodes within the instrument. It can be controlled from the front panel, or through HP–IB, to make voltage and frequency measurements just like a voltmeter, oscilloscope, or frequency counter. The next few paragraphs provide general information about the structure and operation of the analog bus. See *Analog Bus Nodes*, below, for a description of each individual node. Refer to the *Overall Block Diagram*, in the *Troubleshooting* section, to see where the nodes are located in the instrument.

The analog bus consists of a source section and a receiver section. The source can be any one of the 23 nodes described in *Analog Bus Nodes* or the A14 fractional–N VCO, or the A14 fractional–N VCO divided down to 100 kHz. The receiver portion can be either the main ADC or the frequency counter. When analog bus traces are displayed, frequency is the x–axis. For a linear x–axis in time, switch to CW time mode (or sweep a single band).

The Main ADC

The main ADC is located on the A10 assembly and makes voltage measurements in two ranges (see RESOLUTION, above).

The Frequency Counter

The frequency counter is located on the A14 assembly and can count one of three sources: the selected analog bus node, the A14 fractional−N VCO (FRAC N), or the A14 fractional−N VCO divided down to 100 kHz (DIV FRAC N). Its frequency range is 100 kHz to 16 MHz.

The counts are triggered by the phase lock cycle; one each at pretune, acquire, and track for each bandswitch. (The service mode, SOURCE PLL, must be ON for the counter to be updated at each bandswitch). The counter works in swept modes or in CW mode. It can be used in conjunction with SERVICE MODES for troubleshooting phase lock and source problems.

To read the counter over HP−IB, use the command OUTPCNTR.

Notes

- Fast−moving waveforms may be sensitive to sweep time.
- Anything occurring during bandswitches is not visible.
- The analog bus input impedance is about 50K ohms.
- Waveforms up to approximately 200 Hz can be reproduced.
- About 0.750 MHz is a typical counter reading with no AC signal present.
- The display and marker units (U) correspond to volts.

ANALOG BUS NODES

The following paragraphs describe the 23 analog bus nodes. They are listed in numerical order and are grouped by assembly. Refer to the *Overall Block Diagram* for node locations.

Press [USER PRESET] [SYSTEM] SERVICE MENU INPUT PORTS ANALOG BUS and then use the front panel keys or knob to select an analog bus node. Terminate the entry by pressing [x1].

A10 Digital IF

1 **+0.37V** (+0.37V reference)

Check for a flat line at approximately +0.37V. This is used as the voltage reference in the *Analog Bus Correction Constants* adjustment for calibrating out the analog bus high/low resolution gain and offset errors. The absolute voltage level is not critical, but it should be the same in high and low resolution.

2 **+2.50V** (+2.50V reference)

Check for a flat line at approximately +2.5V. This voltage is used in the *Analog Bus Correction Constants* adjustment as a reference for calibrating the analog bus low resolution circuitry.

3 **Aux Input** (Rear panel input)

This selects the rear panel AUX INPUT to drive the analog bus for making voltage and frequency measurements. It can be used to look at test points within the instrument on the CRT (using the CRT as an oscilloscope). Connect the test point of interest to the AUX INPUT BNC connector on the rear panel. This feature can be useful if an oscilloscope is not available. Also, it can be used for testing voltage–controlled devices by connecting the driving voltage of the DUT to the AUX IN connector. You can look at the driving voltage on one display channel while displaying the DUT S–parameter response on the other display channel.

With **AUX OUT** turned ON, you can examine analog bus nodes with external equipment (see **AUX OUT on OFF** under the *Analog Bus Menu* heading). See *HP–IB Service Mnemonic Definitions* for HP–IB considerations.

4 **A10 Gnd** (Ground reference)

This is used in the *Analog Bus Correction Constants* adjustment as a reference for calibrating the analog bus low and high resolution circuitry.

A11 Phase Lock

5 **A11 Gnd** (Ground reference)

6 **A11 Gnd** (Ground reference)

7 **A11 Gnd** (Ground reference)

8 **Swp Err** (Phase error voltage)

This node measures the voltage at the output of the phase comparator on the A11 phase lock assembly. This error voltage corresponds to the difference in frequency between the divided IF and the 1 MHz reference frequency from the A12 assembly.

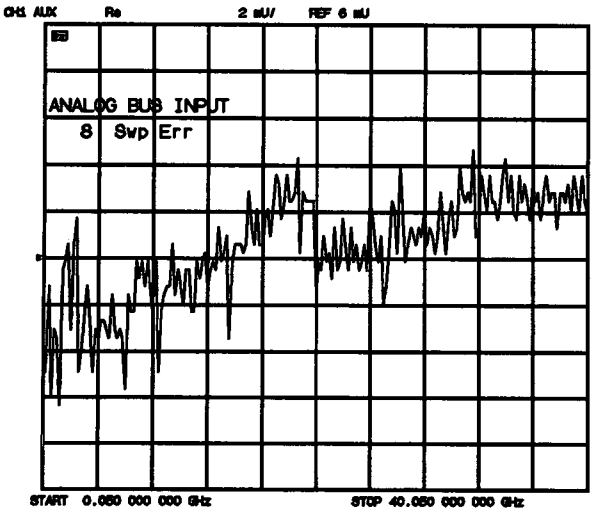


Figure 13–4. Node 8: Swp Err, Phase Error Voltage

9 0.25V/GHz (Source oscillator tuning voltage)

This node displays the tuning voltage ramp used to tune the source oscillators. You should see a voltage ramp like the one shown in Figure 13–5. If this waveform is correct, you can be confident that the A11 phase lock assembly, the source assemblies, the A13/A14 fractional–N assemblies, and the A52 pulse generator are working properly and the instrument is phase locked. If you see anything else, refer to the *Source* troubleshooting section.

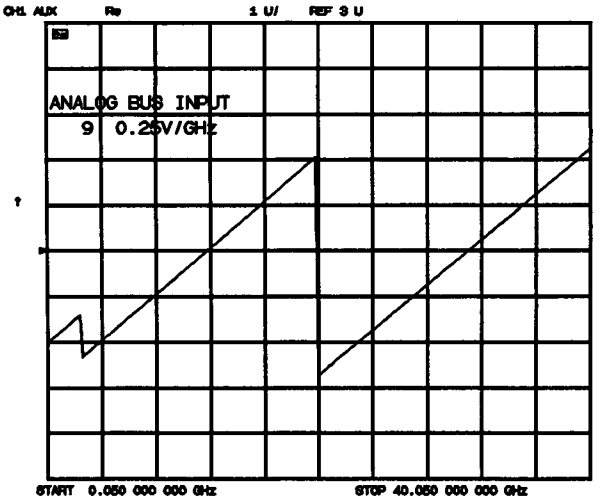


Figure 13–5. Node 9: 0.25V/GHz, Source Tuning Voltage

10 **A11 Gnd** (Ground reference)

11 **IF** (IF used for phase lock)

Counter ON: analog bus Reading: 10 MHz

This node displays the IF frequency (see Figure 13–6) as it enters the A11 phase lock assembly via the A7 ALC assembly. This signal comes from the R sampler output and is used to phase lock the source.

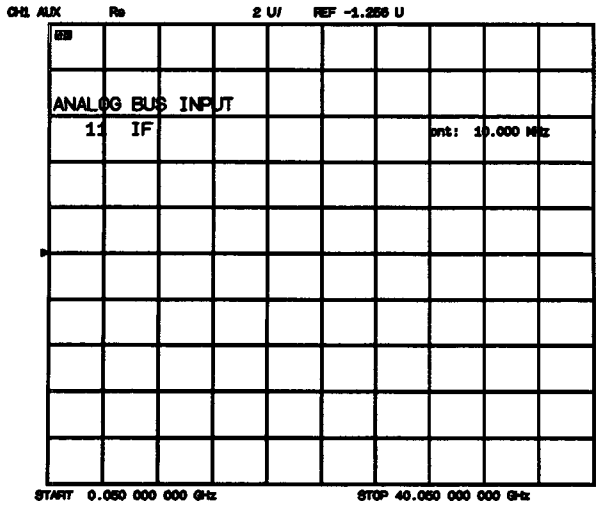


Figure 13–6. Location of Internal Counter Reading on CRT

12 IF Det (IF on A11 phase lock after 40 MHz filter)

This node detects the IF as a voltage at the output of the 40 MHz filter on the A11 phase lock assembly. The trace should be a flat line at about —1.7V as shown in Figure 13–7.

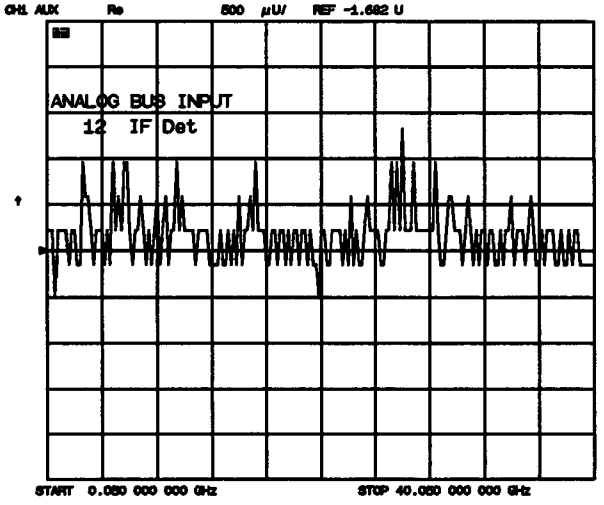


Figure 13–7. Node 12: Typical IF Detector Voltage Trace

A12 Reference

13 Ext Ref (Rear panel external reference input)

This node is used to detect an external reference voltage. If an external reference (timebase) is used, the voltage level should be about —0.6V. If an external reference is not used, the voltage level should be about —0.87V.

14 **100 kHz** (100 kHz reference frequency)

Counter ON: analog bus

Reading: .100 MHz

This node counts the A12 100 kHz reference signal that is used on A13 (the fractional–N analog assembly) as a reference frequency for the phase detector.

15 **VCO Tune** (A12 VCO tuning voltage)

This node displays the tuning voltage for the A12 VCO. It is used in the reference assembly VCO tune adjustment.

16 **2nd LO** (2nd converter reference)

Counter ON: analog bus

Reading: 9.996 MHz

This node counts the 2nd LO used by the 2nd converter assemblies to produce the 2nd IF of 4 kHz.

17 **PL Ref** (Phase lock reference)

Counter ON: analog bus

Reading: 1 MHz

This node counts the reference signal used by the phase comparator circuit on the A11 phase lock assembly.

18 **VCXO Tune** (40 MHz VCXO tuning voltage)

This node displays the voltage used to fine tune the A12 reference VCXO to 40 MHz. You should see a flat line at some voltage level (the actual voltage level varies from instrument to instrument). Anything other than a flat line indicates that the VCXO is tuning to different frequencies. Refer to the frequency accuracy adjustment in the *Adjustments* section.

19 **A12 Gnd** (Ground reference)

20 **A12 Gnd** (Ground reference)

A14 Fractional–N (Digital)

21 **FN VCO Tun** (A14 FN VCO tuning voltage)

This node displays the A14 FN VCO tuning voltage. This voltage comes from the A13 fractional–N (analog) assembly and is the return path for the fractional–N phase–locked loop. If the A13 and A14 assemblies are functioning properly and the VCO is phase locked, the trace should look like the trace shown in Figure 13–8 when in Log Freq. sweep mode. Any other waveform indicates that the FN VCO is not phase locked. The vertical lines in the trace indicate the band crossings. (The counter can also be enabled to count the VCO frequency. Use CW mode.)

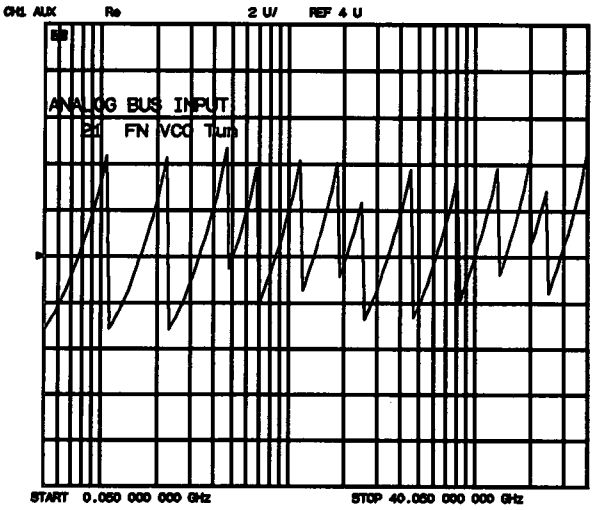


Figure 13–8. Node 21: FN VCO Tun, FN VCO Tuning Voltage

22 **A14 Gnd** (Ground reference)

23 **Count Gate** (Analog bus counter gate)

This node checks the analog bus counter gate signal. You should see a flat line at +5V. The counter gate activity occurs during bandswitches, and therefore is not visible on the analog bus. To view the bandswitch activity, look at this node on an oscilloscope, using **AUX OUT ON** (refer to **AUX OUT on OFF** under the *Analog Bus Menu* heading.

HP–IB SERVICE MNEMONIC DEFINITIONS

All service routine keystrokes have equivalent remote HP–IB commands. Most of the service mnemonics have been documented previously with the corresponding keystroke. A few unique softkeys are documented here.

Undocumented softkeys must be accessed remotely by invoking the system menu (MENUSYST) and using the BASIC command (SOFTn), where "n" represents the softkey number. Softkeys are numbered 1 to 8 from top to bottom.

An HP–IB overview for the analyzer is provided in chapter 12 of the *Reference*. HP–IB programming information is also provided in the *HB–IB Programming Guide* and the *HP–IB Quick Reference*.

Invoking Tests Remotely

Many tests require operator response to displayed prompts. These prompts can be anticipated and the appropriate response sent remotely, over the bus, to the network analyzer.

- Any time a service routine prompts the user and waits for a response, or when the test finishes, bit 1 of the Event Status Register B is set (bit 1 =service routine waiting). Reading this register resets the bit.Initiate the test and either wait in a loop for the "service routine waiting" bit to be set, or enable the bit to interrupt (ESNB[D]). See *Status Reporting* in the *Introductory Programming Guide.*

Symbol Conventions

[ ]	An optional operand
D	A numerical operand
< >	A necessary appendage
|	An either/or choice in appendages.

Analog Bus Codes

ANAI[D] Measures and displays the analog input. The preset state input to the ABUS is the rear panel AUX IN. The other 22 nodes may be selected with [D] only if the ABUS is enabled (ANABon).

OUTPCNTR Outputs the counter's frequency data.

OUTPERRO Reads any prompt message sent to the error queue by a service routine.

OUTPTESS Outputs the integer status of the test most recently executed. Status codes are those listed under TST?.

TST? Executes the power–on self test and outputs an integer test status. Status codes are as follows:

0 = pass
1 = fail
2 = in progress
3 = not available
4 = not done
5 = done

ROM/RAM TESTS

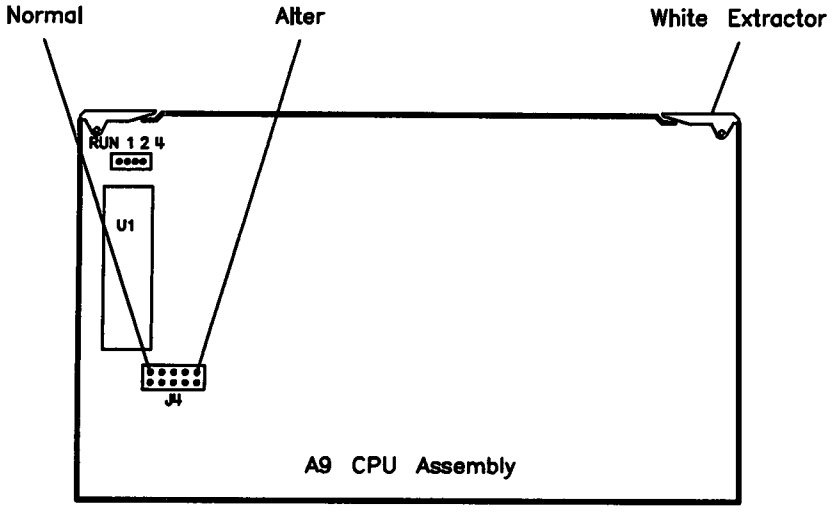


Figure 13–9. A9 CC Jumper Location

These tests, internal tests 2 through 4, are normally run at preset and power–on. However a jumper on the A9 CPU assembly (see Figure 13–9) can be set in one of five positions with the following results:

Position	Result
ALTER	With the jumper in this far right (or top) position, correction constants can be altered, written over in EEPROM. This is used only for correction constant adjustments. Internal tests 2 through 4 are not performed.
CMOS	This **destructive** version of the CMOS RAM test (internal test 3) continuously writes over information stored there.
DRAM	This **destructive** version of the main DRAM test (internal test 4) continuously writes over information stored there.
SKIP	This position skips ROM and RAM testing.
NORMAL	The far left (or bottom) position is the normal position. In this position, EEPROM is protected, and ROM and non–destructive RAM tests are run.

For additional information, see *Internal Tests* (near the front of this section) and the *Digital Control* troubleshooting section.

ERROR TERMS

Chapter 14. Error Terms

INTRODUCTION

Error terms are factors used for error correction, or accuracy enhancement, in the analyzer when correction is turned on. Error terms are numbers generated and stored in internal arrays during a measurement calibration. They are also known as E−terms or measurement calibration coefficients.

Error terms can also serve a diagnostic purpose. Specific parts of the analyzer and its accessories directly contribute to the magnitude and shape of the error terms. Since we know this correlation and we know what typical error terms look like, we can examine error terms to monitor system performance or to identify faulty components in the system.

Error terms are created by measuring well−defined calibration devices over the frequency range of interest and comparing the measured data with the ideal model for the devices. The differences represent systematic (repeatable) errors of the network analyzer system. The resulting calibration coefficients are good representations of the systematic error sources. For details on error correction, refer to Chapter 6 of the *Operating Manual*.

Use the procedures below to generate and examine error terms. No external controller is required. This information can be useful in two ways:

- **Preventive Maintenance**. A stable, repeatable system should generate repeatable error terms over long time intervals, for example, six months. Make a hardcopy record (print or plot) of the error terms, then periodically compare current error terms with the record. A sudden shift in error terms reflects a sudden shift in systematic errors, and may indicate the need for further troubleshooting. A long−term trend often reflects drift, connector and cable wear, or gradual degradation, indicating the need for further investigation and preventive maintenance. Note that the system may still conform to specifications. The cure is often as simple as cleaning and gauging connectors or inspecting cables.

- **Troubleshooting**. If a subtle failure or mild performance problem is suspected, the magnitude of the error terms should be compared against values generated previously with the same instrument and calibration kit. This comparison will produce the most precise view of the problem.

  However, if previously generated values are not available, compare the current values to the typical values listed in Table 14−2, *Uncorrected Performance*, and shown graphically on the plots in this section. If the magnitude exceeds its limit, the corresponding system component should be inspected. If the condition causes system verification to fail, the component should be replaced.

Consider the following while troubleshooting:

- All parts of the network analyzer system, including cables and calibration devices, can contribute to systematic errors and impact the error terms.
- Connectors must be clean, gauged, and within specification for error term analysis to be meaningful.
- Avoid unnecessary bending and flexing of the cables following measurement calibration, to minimize cable instability errors.
- Use good connection techniques during the measurement calibration. The connector interface *must* be repeatable. Refer to the *Microwave Connector Care Manual* for information on connection techniques and on cleaning and gauging connectors.
- Use error term analysis to troubleshoot minor, subtle performance problems. Refer to the *Troubleshooting* section if a blatant failure or gross measurement error is evident.
- It is often worthwhile to perform the procedure twice (using two distinct measurement calibrations) to establish the degree of repeatability. If the results do not seem repeatable, check all connectors and cables.

MEASUREMENT CALIBRATION PROCEDURE

1. Press [RECALL] RECALL FAC PRESET [CAL] CALIBRATE MENU FULL 2-PORT to perform a full 2-port calibration (with slight modifications):

This calibration sequence is comprised of three parts:

REFLECTION: For these measurements (short, open, loads), connect the calibration device directly to the test port. Use the female devices for port 1. Adapt the male devices for port 2.

TRANSMISSION: Use a single cable or cable pair (consistent with the normal use of the system) for these measurements.

ISOLATION: Leave the cables connected for this measurement. Press [AVG] IF BW [1] [0] [x1] to change the IF bandwidth to 10 Hz. Then press [CAL] RESUME CAL SEQUENCE ISOLATION. Connect leads to cable end and port.

2. Store this calibration into an internal register or on disk.

Table 14–1. Calibration Coefficient Terms and Tests

Cal Coeff.	Calibration Type				Test Number
	Response	Resp & Isol'n[1]	1–port	2–port	
1	E_R or E_T	E_X E_D	E_D	E_{DF}	31
2		E_T (E_R)	E_S	E_{SF}	32
3			E_R	E_{RF}	33
4				E_{XF}	34
5				E_{LF}	35
6				E_{TF}	36
7				E_{DR}	37
8				E_{SR}	38
9				E_{RR}	39
10				E_{XR}	40
11				E_{LR}	41
12				E_{TR}	42

NOTES:

- Meaning of first subscript:D=directivity; S=source match; R=reflection tracking; X=crosstalk; L=load match; T=transmission tracking.
- Meaning of second subscript:F=forward; R=reverse.

1. Resp & Isol'n cal yields: E_X or E_T if a transmission parameter (S_{21}, S_{12}) or E_D or E_R if a reflection parameter (S_{11}, S_{22})

ERROR TERM INSPECTION

NOTE: If correction is not on, press [CAL] CORRECTION ON now.

Press [SYSTEM] SERVICE MENU TESTS [3] [1] [x1] EXECUTE TEST to display the first calibration measurement trace (Table 14–1 lists the test numbers). The test copies the calibration measurement trace for the selected error term into display memory and displays it.

Use the scale, reference, and marker functions to study the error term trace and determine its magnitude. Compare it to the *Error Term Descriptions* below and to earlier data measured on the system. If system–specific data is not available, refer to the typical uncorrected performance specifications listed in Table 14–2. To make a hardcopy of a trace, see *Hardcopy Procedure*, below.

If an error term seems much worse than the typical values, you may want to perform a system verification to make sure that the system still conforms to specifications. If system verification fails, refer to *Troubleshooting.*

Table 14–2. Uncorrected Performance

UNCORRECTED PERFORMANCE The following table shows typical performance without accuracy enhancement. RF cables not used except as noted.				
	Frequency Range (GHz)			
	0.05 to 2	**2 to 8**	**8 to 20**	**20 to 40**
Directivity	20 dB	18 dB	18 dB	16 dB
Source Match	20 dB[3]	15 dB	12 dB	12 dB
Load Match[2]	23 dB	18 dB	14 dB	12 DB
Reflection Tracking[1]	±1.5 dB	±2 dB	±2.5 dB	±3 dB
Transmission Tracking[1,2]	±1.5 dB	±2 dB	±2 dB	±2.5 dB
Crosstalk	85 dB	85 dB	85 dB	70 dB

1. Excludes 0/–5 dB slope, typical, in magnitude response from .84 to 40 GHz and rolloff below .84 GHz, which is typically —3 dB at 500 MHz, —15 dB at 100 MHz, and —20 dB at 50 MHz.
2. Measured with RF cables.
3. 18 dB, 0.05 to 0.065 GHz

Hardcopy Procedure

To make a hardcopy record of the trace: Connect a printer or plotter and press LOCAL SYSTEM CONTROLLER COPY PRINT (or PLOT). Title each trace with the title feature or manually so that it can be identified later. Refer to Chapter 10 of the *Reference* for more copying information.

ERROR TERM DESCRIPTIONS

Following are descriptions of each error term, its significance, typical results, and guidelines to interpretation. The same description applies to both the forward (F) and reverse (R) terms. The plots shown with each are typical of a working system following a full 2–port calibration as performed in *Measurement Calibration Procedure*, above.

It may be helpful to define some of the terms used in the descriptions below:

- R signal path: refers to the reference signal path. It includes the M/D/S (M/A/D/S) A58, R sampler A64, and associated semi–rigid coax cables.
- A input path: refers to the port 1 input path and includes the M/D/S (M/A/D/S) A58, step attenuator A69, transfer switch S4, bias tee A61, directional coupler A62, and A sampler A65, and associated semi–rigid coax cables.
- B input path: refers to the port 2 input path. It includes the M/D/S (M/A/D/S) A58, step attenuator A69, transfer switch S4, bias tee A60, directional coupler A63, and B sampler A66, and associated semi–rigid coax cables.

Directivity (EDF and EDR)

Description. These are the uncorrected forward and reverse directivity error terms of the system. The directivity error of the test port is determined by measuring the S11 and S22 reflection of the calibration kit load. The load has a much better return loss specification than does the uncorrected test port, therefore any power detected from this measurement is assumed to be due to directivity error.

Significant System Components. The load used in the calibration is the most important component. The test port connector, the cable, and the coupler also greatly affect the measured directivity error.

Affected Measurements. The measurements most affected by directivity errors are measurements of low reflection devices; highly reflective device measurements will appear normal.

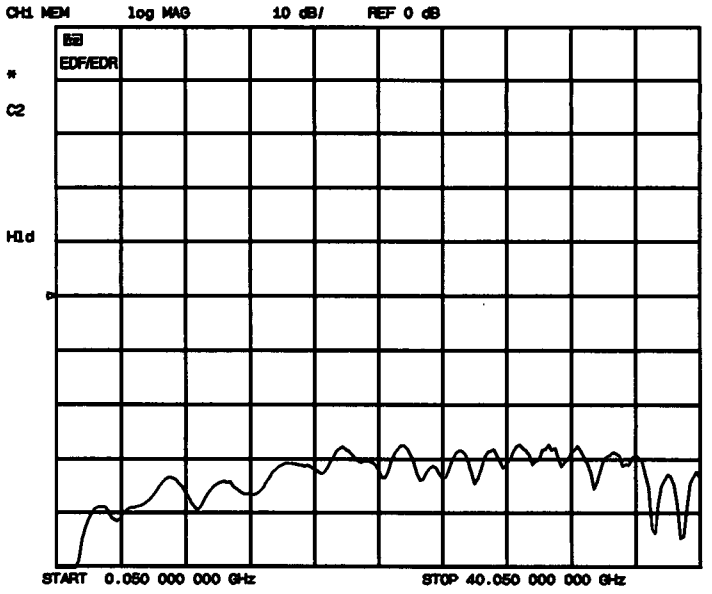


Figure 14–1. Typical EDF/EDR Without Cables

Source Match (ESF and ESR)

Description. These are the forward and reverse uncorrected source match terms of the driven port. They are obtained by measuring the reflection (S11, S22) of an open and then a short connected directly to the ports. Source match is a measure of the match between the coupler and test set connector, as well as the match between all components from the source to the output port.

Significant System Components. The open and short calibration devices are important, as are the coupler and test port connectors. The power splitter, bias tees, step attenuator, and transfer switch may also contribute to source match errors.

Affected Measurements. The measurements most affected by source match errors are reflection and transmission measurements of highly reflective DUTs.

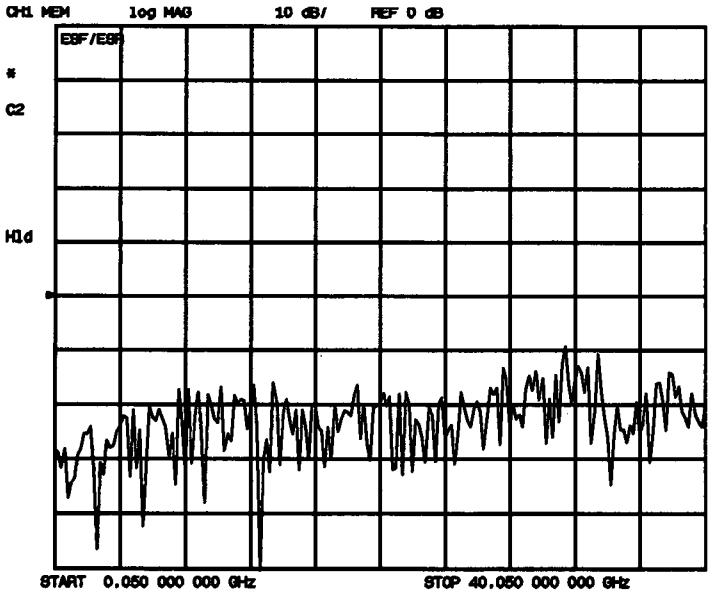


Figure 14–2. Typical ESF/ESR Without Cables

Reflection Tracking (ERF and ERR)

Description. Reflection tracking is the difference between the frequency response of the reference path (R path) and the frequency response of the reflection test path (A or B input path). These error terms are characterized by measuring the reflection (S11, S22) of the open and the short during the measurement calibration. Note that coupler response is included in this error term. Typically this appears as a slope of 0/−5 dB from 0.84 GHz to 40 GHz and a roll−off below 0.84 GHz, which is typically −3 dB at 500 MHz, − 15 at 100 MHz, and −20 at 50 MHz.

Significant System Components. The open and short calibration devices have an effect on reflection tracking. But large variations in this error term may indicate a problem in one of the signal paths. Suspect the R signal path if the problem appears in both ERF and ERR. Troubleshoot the A or B input paths first if only one reflection tracking term is affected.

Affected Measurements. All reflection measurements (high or low return loss) are affected by the reflection tracking errors.

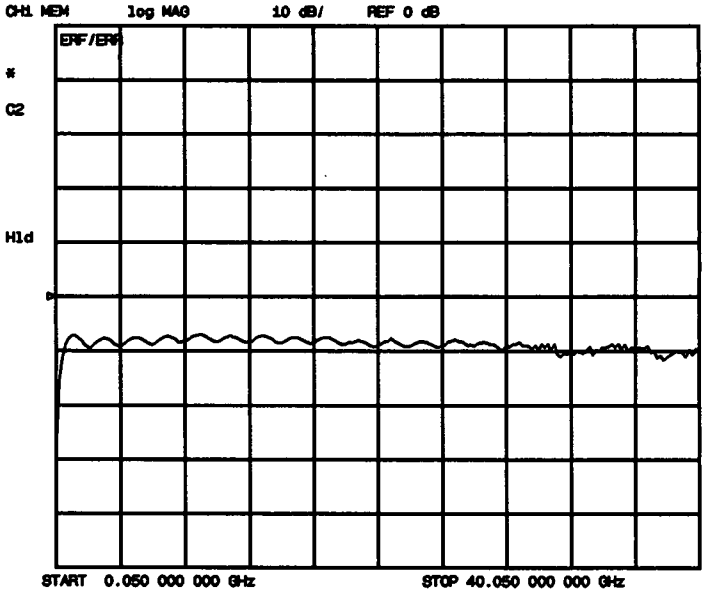


Figure 14−3. Typical ERF/ERR

Isolation (Crosstalk, EXF and EXR)

Description. These are the uncorrected forward and reverse isolation error terms that represent leakage between the test ports and the signal paths. The isolation error terms are characterized by measuring transmission (S21, S12) with loads attached to both ports during the measurement calibration. Since these terms are low in magnitude, they are usually noisy (not very repeatable). The error term magnitude changes dramatically with IF bandwidth: a 10 Hz IF bandwidth must be used in order to lower the noise floor beyond the crosstalk specification. Using averaging will also reduce the peak–to–peak noise in this error term.

Significant System Components. Loose cable connections or leakage between components in the lower box are the most likely cause of isolation problems. The transfer switch, bias tees, couplers, and samplers are the most susceptible components.

Affected Measurements. Isolation errors affect both reflection and transmission measurements, primarily where the measured signal level is very low. Examples include reflection measurements of a well–matched DUT, and transmission measurements where the insertion loss of the DUT is large.

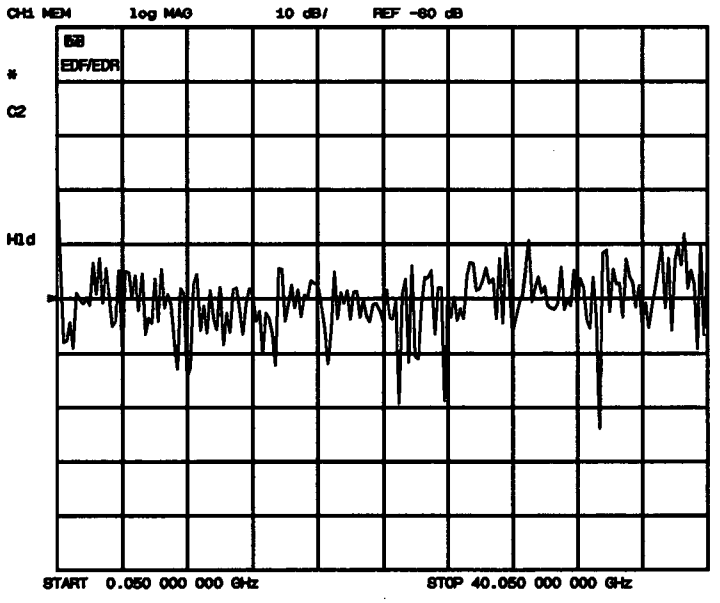


Figure 14–4. Typical EXF/EXR with 10 Hz Bandwidth

Load Match (ELF and ELR)

Description. Load match is a measure of the impedance match of the test port that terminates the output of a 2–port device. The match of test port cables is included. Load match error terms are characterized by measuring the S11 and S22 responses of a "thru" configuration during the calibration procedure.

Significant System Components. Large variations in the forward or reverse load match error terms may indicate a bad "thru" cable or a poor connection of the cable to the test port.

Affected Measurements. The measurements most affected by load match errors are all transmission measurements, and reflection measurements of a low insertion loss two–port device, such as an airline.

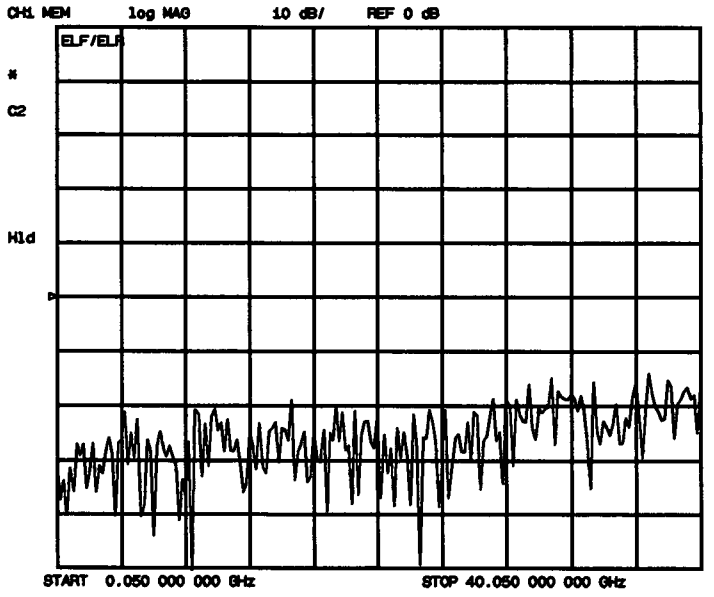


Figure 14–5. Typical ELF/ELR

Transmission Tracking (ETF and ETR)

Description. Transmission tracking is the difference between the frequency response of the reference path (including R input) and the frequency response of the transmission test path (including A or B input) while measuring transmission. The response of the test port cables is included. These terms are characterized by measuring the transmission (S21, S12) of the "thru" configuration during the measurement calibration. Note that coupler response is included in this error term. Typically transmission tracking appears as a slope of 0/−5 dB from 0.84 GHz to 40 GHz and a roll−off below 0.84 GHz, which is typically −3 dB at 500 MHz, − 15 at 100 MHz, and −20 at 50 MHz.

Significant System Components. Large variations in this error term probably indicate a problem in the reference signal path (if both ETF and ETR are bad) or in the A or B input path. The "thru" cable also has an effect on transmission tracking.

Affected Measurements. All transmission measurements are affected by transmission tracking errors.

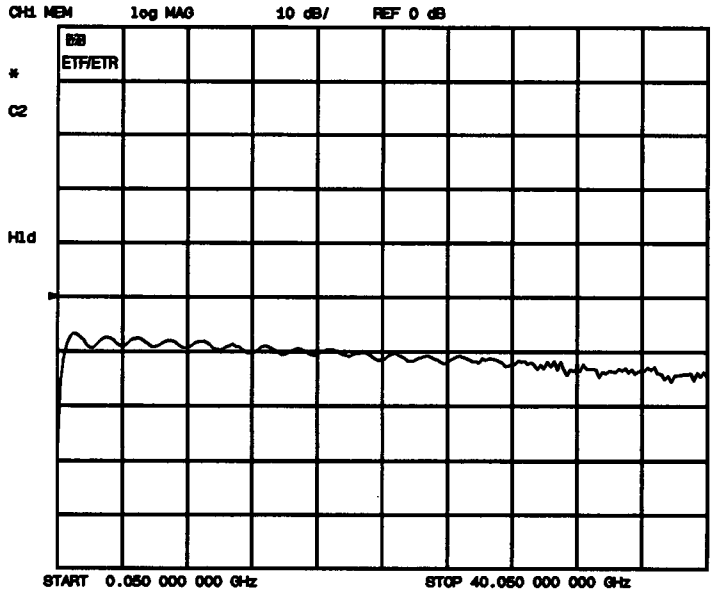


Figure 14−6. Typical ETF/ETR

THEORY OF OPERATION

Chapter 15. Theory of Operation

INTRODUCTION

Theory of Operation provides a general description of the system, and operating theory of the network analyzer functional groups. Operation is explained to the assembly level only: component–level circuit theory is not provided. Simplified block diagrams illustrate the operation of each functional group. An overall block diagram is provided at the end of the section.

SYSTEM OPERATION

The HP 8722 microwave network analyzer integrates a synthesized source, signal separation devices, a three–channel receiver for measurement of test device characteristics, and a large–screen display. Figure 15–1 is a simplified block diagram of the network analyzer system.

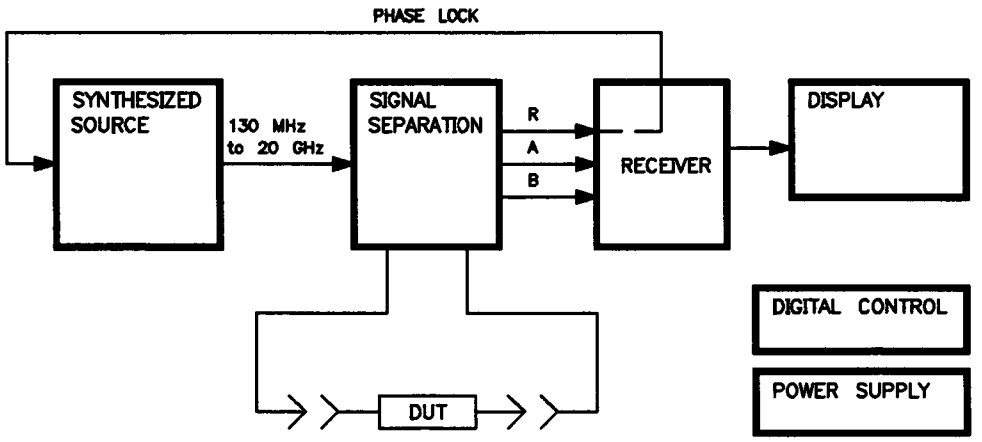


Figure 15–1. Simplified System Block Diagram

The built–in synthesized source of the HP 8722 generates a swept or CW (continuous wave) signal in the range of 50 MHz to 40 GHz. The source output power is leveled by an internal ALC (automatic leveling control) circuit, to a maximum level of −15 dBm (−5 dBm for the HP 8722C) at the front panel measurement ports. A portion of the source signal is routed to the R sampler in the receiver, and fed back to the source for phase lock.

The signal separation devices separate the source signal into a reference path and a test path. They provide attenuation for the source signal, RF path switching to allow forward and reverse measurements, and external connections for the DUT (device under test). The signal transmitted through or reflected from the DUT goes to the receiver for comparison with the reference signal.

The receiver converts the source signal to a 4 kHz IF (intermediate frequency) for signal processing, retaining both magnitude and phase characteristics. The IF is converted to digital signals, which are processed into magnitude and phase information. The processed and formatted data is finally routed to the CRT for display, and to the HP-IB for remote operation. Details of analyzer data processing are provided in Chapter 2 of the *Operating and Programming Reference*.

In addition to the analyzer, the system includes cables for interconnections, and calibration standards for accuracy enhanced measurements.

FUNCTIONAL GROUPS OF THE ANALYZER

The operation of the analyzer is most logically described in five functional groups. Each group consists of several major assemblies, and performs a distinct function in the instrument. Some assemblies are related to more than one group, and in fact all the groups are to some extent interrelated and affect each other's performance.

Power Supply. The power supply functional group provides power for the other assemblies in the instrument.

Digital Control. The digital control group, which includes the front and rear panels and the display, as well as the CPU, provides control to all assemblies in the network analyzer. The graphics signal processor (GSP) provides an interface between the CPU and the display.

Source. The source group supplies a phase-locked and leveled microwave signal to the device under test.

Signal Separation. The signal separation group performs the function of an S-parameter test set, dividing the source signal into a reference path and a test path, and providing connections to the device under test.

Receiver. The receiver group measures and processes the input signals for display.

The following pages describe the operation of the assemblies within each of the functional groups. (Note that assemblies numbered A51 and above are located in the lower portion of the instrument, and all others are in the upper portion.)

POWER SUPPLY THEORY

The power supply functional group consists of the A15 preregulator and the A8 post–regulator. These two assemblies constitute a switching power supply that provides regulated DC voltages to power all assemblies in the network analyzer. The A15 preregulator is enclosed in a casting at the rear of the instrument behind the display. It is connected to the A8 post–regulator by a wire bus A15W1. Figure 15–2 is a simplified block diagram of the power supply group (for a more detailed diagram, refer to the *Power Supply* tab in the troubleshooting section).

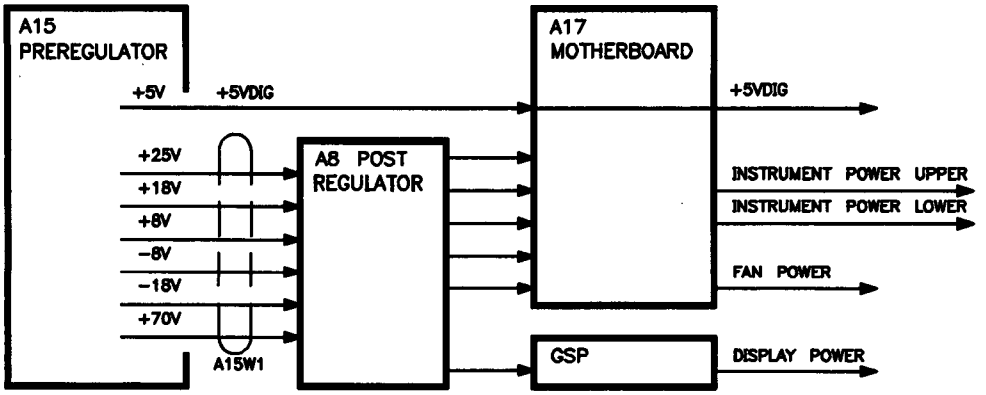


Figure 15–2. Power Supply Functional Group, Simplified Block Diagram

A15 Preregulator

The A15 preregulator rectifies and steps down the line voltage. It provides a fully regulated +5V digital supply, and several preregulated voltages that go to the A8 post–regulator assembly for additional regulation. It includes the line power module, a 60 kHz switching preregulator, and overvoltage protection for the +5V digital supply. It provides LEDs, visible from the rear of the instrument, to indicate circuit status.

Line Power Module. The line power module includes the line power switch, voltage selector switch, and main fuse. The line power switch is activated from the front panel. The voltage selector switch, accessible at the rear panel, adapts the network analyzer to local line voltages of approximately 115V or 230V. The main fuse, which protects the input side of the preregulator against drawing too much line current, is also accessible at the rear panel. Refer to the *User's Guide* for line voltage tolerances and other power considerations.

Preregulated Voltages. The switching preregulator converts the line voltage to several DC voltages. The preregulated +5V digital supply goes directly to the motherboard. The following preregulated voltages are routed through A15W1 to the A8 post–regulator for final regulation:

+25V	+8V	—18V
+18V	—8V	+70V

The +5V Digital Supply. The +5VD supply is regulated by a control loop in the A15 preregulator. It goes directly to the motherboard, and from there to all assemblies requiring a digital supply. A +5V sense line returns from the motherboard to the A15 preregulator. The +5VCPU line is derived directly from the +5VD, but a different line takes it through the motherboard and the A8 post–regulator to the A9 CPU assembly, and the A1/A2 front panel.

The preregulator will only function if the +5V digital supply is loaded by one or more assemblies, and if the +5V sense line is working. If not, the other preregulated voltages will not be correct.

Shutdown Indications: the Green and Red LEDs. Two power supply LEDs are visible through the rear panel casting. The green LED is on in normal operation. It is off if line power is not connected or not turned on; if the voltage selector switch on the rear panel is set incorrectly; or if the line fuse has blown.

The red LED, which is off in normal operation, lights to indicate a fault in one or more of the preregulated voltages. This may be an overvoltage, undervoltage, overcurrent, or overtemperature condition. Refer to the *Power Supply* tab in the troubleshooting section for more information.

A8 Post–Regulator

The A8 post–regulator filters and regulates the DC voltages received from the A15 preregulator. It provides fusing and shutdown circuitry for individual voltage supplies. It distributes regulated constant voltages to individual assemblies throughout the instrument. It includes an overtemperature shutdown circuit, the variable fan speed circuit, and the air flow detector. Nine green LEDs provide status indications for the individual voltage supplies.

Voltage Indications: the Green LEDs. The green LEDs along the top edge of the A8 assembly are on in normal operation, to indicate the correct voltage is present in each supply. If they are off or flashing, a problem is indicated. The steps to trace the cause of the problem are explained under *Power Supply* in the troubleshooting section.

Shutdown Circuit. The shutdown circuit is triggered by overcurrent, overvoltage, undervoltage, or overtemperature. It protects the instrument by causing the regulated voltage supplies to be shut down. It also sends status messages to the A9 CPU to trigger warning messages on the CRT. The following voltages are not shut down:

+5VD and +5VCPU digital supplies from A15
fan power
display power

The shutdown circuit can be disabled **momentarily** for troubleshooting purposes by jumpering the SDIS test point on the A8 board to ground.

Variable Fan Circuit and Air Flow Detector. The fan power is derived directly from the +18V and —18V supplies from the A15 preregulator. The fan is not fused, so that it will continue to provide airflow and cooling when the instrument is otherwise disabled. If overheating occurs, the main instrument supplies are shut down and the fan runs at full speed. An overtemperature status message is sent to the A9 CPU to initiate a warning message on the CRT. The fan also runs at full speed if a low airflow situation is detected, such as a clogged air filter or inadequate clearance. (Full speed is normal at initial power–on if the instrument is warm.)

Display Power. The A8 post regulator supplies the A19 GSP assembly with +5VCPU and +65V. The +5VCPU is used by the A19 GSP (but not the A18 display). The +65V is used by the A18 display (but not the A19, +65V is only routed through it to the display). Both supply voltages can function (to operate the display) even when other power supplies are shut down. They are individually regulated; not connected to the regular shutdown circuitry.

DIGITAL CONTROL THEORY

The digital control functional group (Figure 15–3) provides control for the entire network analyzer. It provides math processing functions, as well as communications between the analyzer and an external controller and/or peripherals.

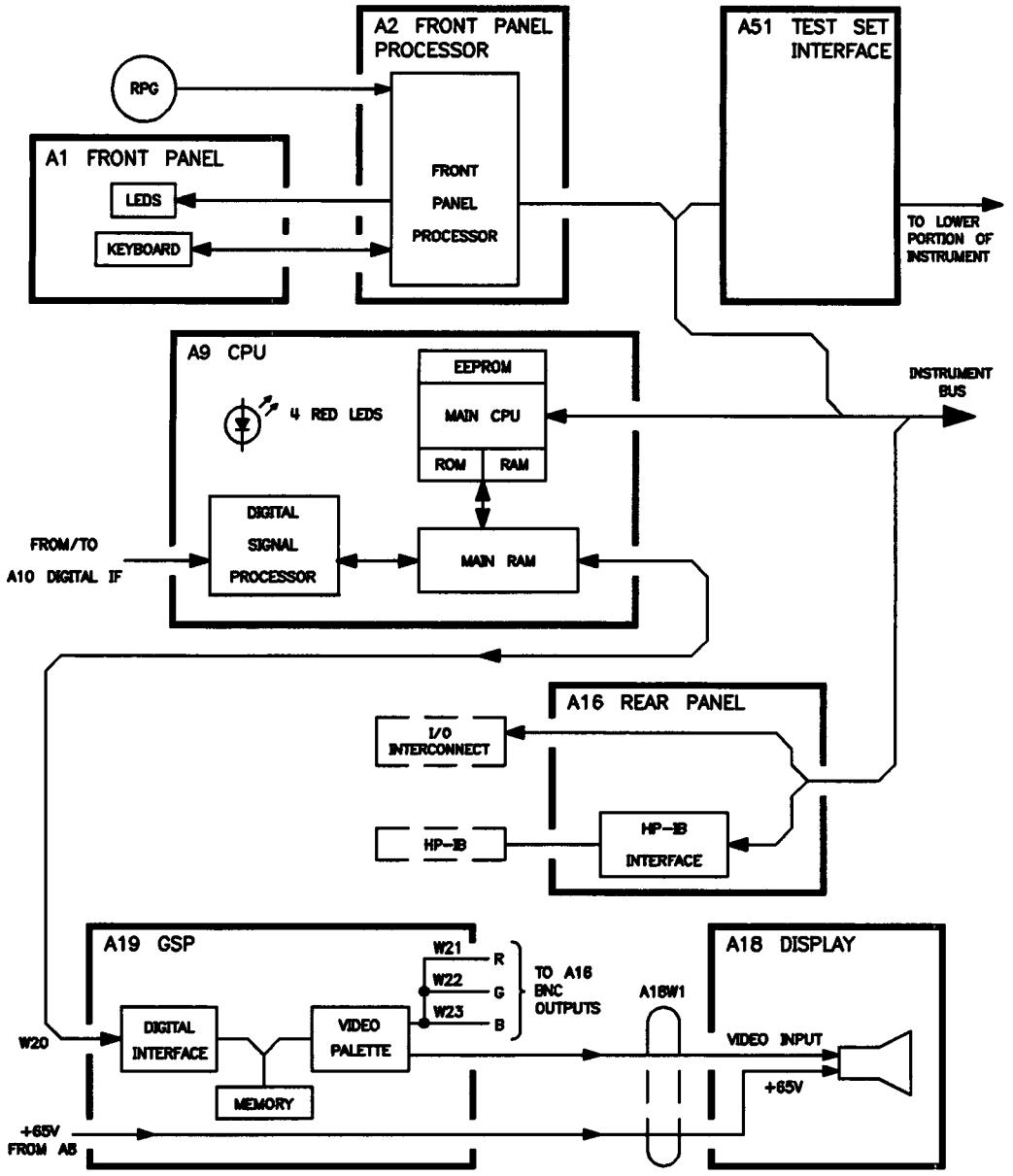


Figure 15–3. Digital Control Group, Simplified Block Diagram

A1 Front Panel

The A1 front panel assembly provides manual user interface with the analyzer. It includes the keyboard for local user inputs, and the front panel LEDs that indicate instrument status. The RPG (rotary pulse generator) is not electrically connected to the front panel, but provides user inputs directly to the front panel processor.

A2 Front Panel Processor

The A2 front panel processor detects and decodes user inputs from the front panel and the RPG, and transmits them to the CPU. It has the capability to interrupt the CPU to provide information updates. It controls the front panel status LEDs; and auxiliary controls for the display focus and intensity to allow softkey control without mechanical adjustment of the display assembly.

A9 CPU

The A9 CPU assembly contains the main CPU (central processing unit), the digital signal processor, and memory storage. The main CPU is the master controller for the analyzer, including the other dedicated microprocessors. The memory includes ROM, RAM, CMOS RAM and EEPROM. Data from the receiver is serially clocked into the A9 CPU assembly from the A10 digital IF.

Main CPU. The main CPU maintains digital control over the entire instrument through the instrument bus. It receives external control information from the front panel or via HP–IB, and performs processing, formatting, and error correction operations on the raw data in the main RAM. It controls the digital signal processor, the front panel processor, the graphics signal processor, the logic circuit in the A51 test set interface assembly, and the HP–IB interface. In addition, when the analyzer is the system controller, the main CPU controls peripheral devices through HP–IB.

ROM. The main CPU has a dedicated ROM (read–only memory) that contains the operating system for instrument control.

CMOS RAM. Front panel settings (instrument states) and calibration sets can be stored in the CMOS RAM (random access memory), with a large capacitor providing at least 72 hours of backup storage when external power is off.

EEPROM. The EEPROM (electrically–erasable programmable ROM) contains factory–set correction constants unique to each instrument. These constants correct for hardware variations to increase performance. To guard against inadvertent correction constant changes, the A9 CPU assembly includes a jumper that is normally set in a write–protect mode. The correction constants can be updated by executing the routines in the *Adjustments and Correction Constants* section of this manual.

Main RAM. The main RAM is a shared memory for the CPU, the digital signal processor, and the display processor. It stores the raw data received from the digital signal processor, while additional calculations are performed on it by the main CPU. The display processor reads the resulting CRT image from the main RAM and displays it on the CRT. The display is updated frequently, and asynchronously with the data processing operations, to provide a flicker–free image. Detailed information on the data processing sequence is provided in chapter 1 of the *Reference*.

Digital Signal Processor. The digital signal processor receives the digitized data from the A10 digital IF. It computes discrete Fourier transforms to extract the complex magnitude and phase data from the 4 kHz IF signal, and performs ratioing and averaging operations. The resulting data is written into the main RAM.

Color Display

The color display consists of two assemblies: the A19 GSP and the A18 display. The A19 GSP is an interface between the A9 CPU and the A18 display. The GSP reads formatted data from the A9 CPU and converts that data to video signals (digital TTL horizontal and vertical synch signals) and RGB signals. It sends the video and RGB signals to the A18 display and to the A16 rear panel. The GSP also passes the +65V supply to the A18 display. The GSP itself uses the +5VCPU supply voltage.

The A18 color display is a 7.5 inch scan CRT with associated drive circuitry. It receives its power and input signals from the A19 GSP as noted above. The A18 automatically degauses itself to minimize color impurity each time the analyzer is turned on.

A16 Rear Panel

The A16 rear panel includes the HP–IB interface, a dedicated bus controller that monitors and controls the handshake and data lines of the external bus. It communicates messages from a remote controller to the CPU, and from the CPU to peripherals on the bus. The network analyzer has red, green and blue video output signals which can be accessed via 3 BNC connectors on rear panel.

The I/O interconnect provides a TTL output signal to indicate pass/fail status during limit testing.

A51 Test Set Interface

The A51 test set interface routes the power and control circuitry from the upper portion of the instrument to the components in the lower portion.

SOURCE GROUP THEORY

The source functional group produces a stable output signal by phase locking a YIG oscillator to a synthesized VCO (voltage controlled oscillator). The full frequency range of the source is generated in subsweeps by harmonic mixing. The output is a swept or CW signal between 50 MHz and 40 GHz, with a maximum leveled power of −15 dBm at the front panel measurement ports (minimum —65 dBm). Figure 15−4 illustrates the operation of the source functional group.

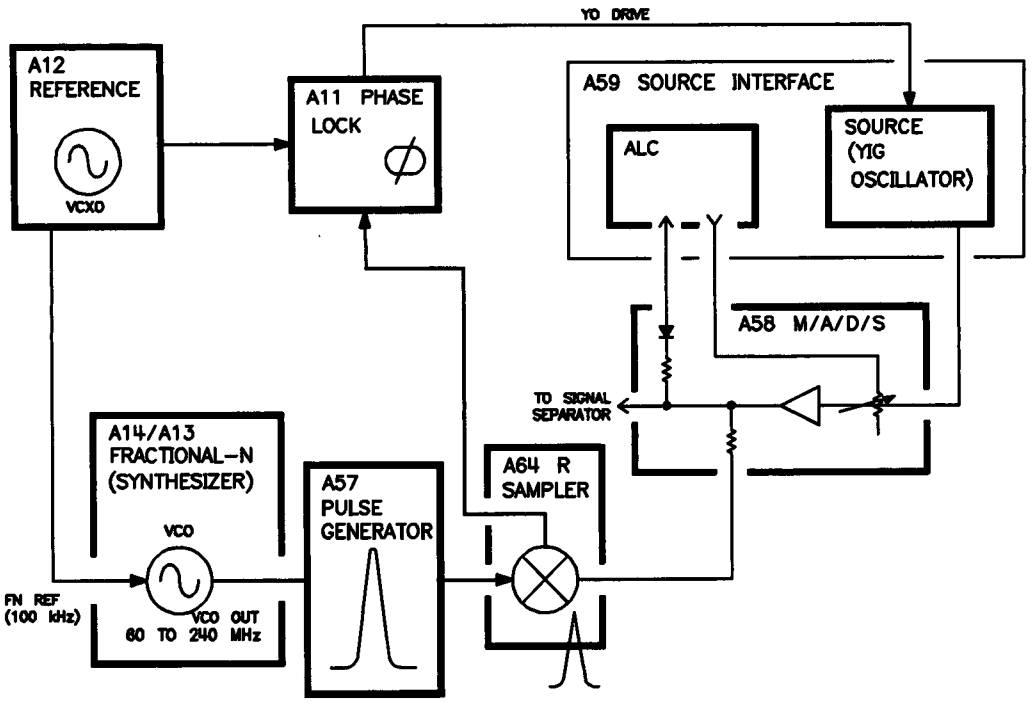


Figure 15−4. Source Functional Group, Simplified Block Diagram

The subsweep sequence takes place in the following steps. The paragraphs below describe the details of this process, and provide additional information on the assemblies in the source group.

1. The source is pretuned low. The source signal (SOURCE OUT) is fed to the R sampler.
2. A signal (VCO OUT) is generated by the VCO in the fractional−N synthesizer.
3. A comb of harmonics (1st LO) is produced in the pulse generator.
4. A synthesizer harmonic (1st LO) and the source signal (SOURCE OUT) are mixed in the sampler. A difference frequency (1st IF) is generated.
5. The 1st IF signal from the R sampler is fed back and compared to a reference. A tune current is generated.

6. The tune current is used to set the frequency of the source YIG oscillator.

7. Phase lock is acquired and a synthesized subsweep is generated. The source tracks the synthesizer.

1. Source Pretune

The pretune DAC (digital–to–analog converter) in the A11 phase lock assembly sets the source YIG oscillator frequency to approximately 2.4 GHz. This signal (SOURCE OUT) goes to the R sampler assembly.

2. A14/A13 Fractional–N Synthesizer

The A14/A13 fractional–N assemblies comprise the synthesizer. The source feedback circuit phase locks the YIG oscillator to the synthesizer output signal as explained below under *A11 Phase Lock: Comparing Phase and Frequency.*

The VCO in the A14 fractional–N (digital) assembly generates a swept or CW signal in the range of 60 to 240 MHz, such that a harmonic is 10 MHz above the desired start frequency. This is divided down and phase locked (in the A13 assembly) to a 100 kHz signal FN REF from the A12 reference. A programmable divider is set to some number, N, such that the integer part of the expression F_{VCO}/N is equal to 100 kHz. To achieve frequencies between integer multiples of the reference, the divider is programmed to divide by N part of the time and by N+1 part of the time. The ratio of the divisions yields an average equal to the desired fractional frequency. API (analog phase interpolator) current sources in the A13 assembly correct for phase errors caused by the averaging. The resulting synthesized signal goes to the pulse generator.

3. A52 Pulse Generator: the Harmonic Comb

The signal from the synthesizer drives a step recovery diode (SRD) in the A52 pulse generator assembly. The SRD generates a comb of harmonic multiples (1st LO) of the VCO frequency, which goes to the samplers. One of the harmonics is 10 MHz above the desired start frequency.

4. A64 R Sampler: Down–Converting the Signals

The A64 assembly is part of the receiver functional group. It is also included here because it is an integral part of the source phase locking scheme. In the R sampler, the 1st LO signal from the pulse generator is mixed with the SOURCE OUT signal from the source. The difference IF (intermediate frequency) produced is nominally 10 MHz. For phase locking, part of this IF signal is routed back to the A11 phase lock assembly. (Additional information on the sampler assemblies is provided in *Receiver Theory.*)

5. A11 Phase Lock: Comparing Phase and Frequency

The 10 MHz 1st IF signal from the A64 sampler is fed back to the A11 phase lock assembly. In A11 it is amplified, limited, and filtered to produce a 10 MHz square wave. This is divided down to 1 MHz, then applied to a phase/frequency detector that compares it to a crystal controlled 1 MHz signal (PL REF) from the A12 reference assembly (see *A12 Reference: the Crystal Reference Frequencies*, below). Any phase or frequency difference between these two signals produces a proportional DC voltage.

6. Tuning the YIG Oscillator

The output of the phase/frequency detector is filtered to remove any 1 MHz feedthrough, and fed to an integrator. The output of the integrator is converted to a tune current. This brings the appropriate YIG oscillator closer to the desired frequency, which in turn reduces the phase/frequency detector output voltage. When the voltage is reduced to zero, and the divided–down 1st IF frequency is equal to the 1 MHz reference frequency PL REF, phase lock is achieved.

7. Phase Locked Sweep

When the source is phase locked to the synthesizer at the start frequency, the synthesizer starts to sweep. The phase–locked loop forces the source to track the synthesizer, maintaining a constant 10 MHz 1st IF signal.

The full sweep is generated in a series of subsweeps, by phase locking the source signal to the harmonic multiples of the synthesizer. At the transitions between subsweeps, phase lock is broken, the source is held at this frequency. Table 15–1 lists the subsweep frequencies from the synthesizer and the source.

Table 15–1. Subsweep Frequencies

Band	Synthesizer (MHz)	Harmonic Number (N)	Source (MHz) Frequency
Low	60 – 120	1	50 – 110
	120 – 240	1	110 – 230
	120 – 240	2	230 – 470
	160 – 236	3	470 – 698
	141.6 – 236	5	698 – 1170
	147.5 – 236	8	1170 – 1878
	157.3 – 213.3	12	1878 – 2550
Mid	128 – 236	20	2550 – 4710
	131.1 – 229.6	36	4710 – 8256
	142.5 – 234	58	8256 – 13562
	159.7 – 235.4	85	13562 – 20000
High	178.7 – 223.3	112	20000 – 25000
	148.9 – 238.2	168	25000 – 40000

A12 Reference: the Crystal Reference Frequencies

This assembly provides stable reference frequencies to the rest of the instrument by dividing down the output of a 40 MHz VCXO (voltage–controlled crystal oscillator). One of the divided–down signals is the 100 kHz FN REF for phase locking the synthesizer signal in A13. Another is the 1 MHz main phase–locked loop reference signal PL REF that goes to the phase comparator in A11.

(The 2nd LO signal and the timing signal for the A10 digital IF assembly are explained in *Receiver Theory*.)

The EXT REF rear panel input provides the option of using an external reference with a frequency of 1, 2, 5, or 10 MHz, instead of the internal 40 MHz VCXO.

Source Block: The YIG Oscillator Signals

The source block includes two YIG oscillators and a 3.8 GHz fixed oscillator. The outputs of these oscillators produce the source signal. In phase–locked operation, this signal tracks the stable output of the synthesizer. Figure 15–5 illustrates the assemblies in the source block.

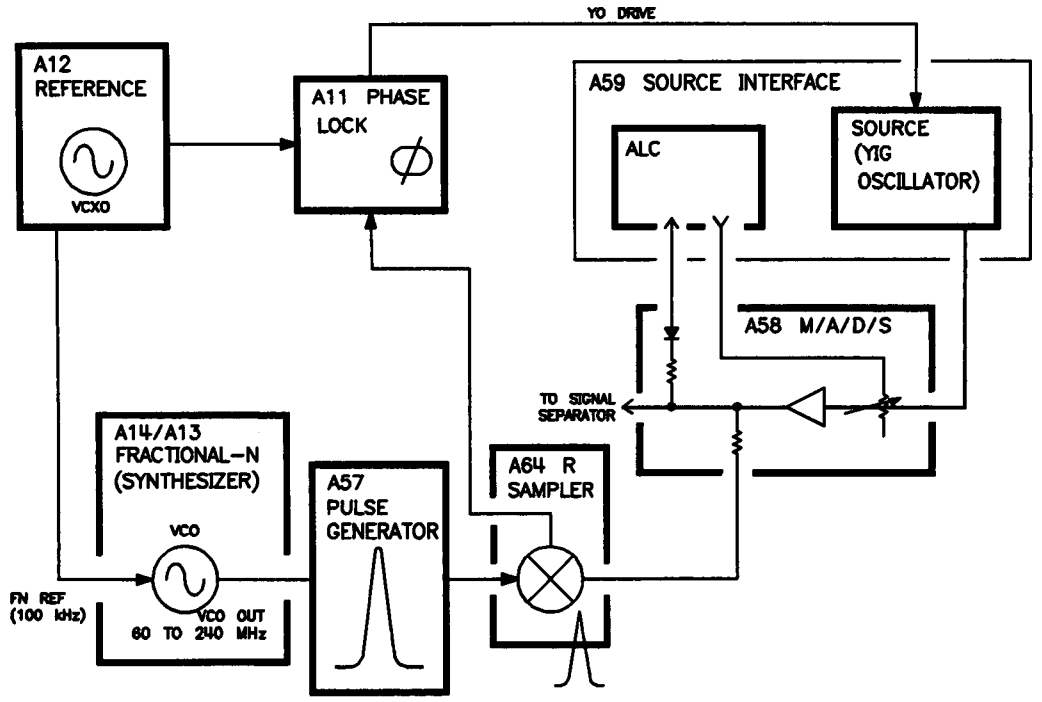


Figure 15–5. Simplified Diagram of the Source Block

The YIG oscillator has a main coil and an FM coil. These are analogous to the woofer and the tweeter in a stereo speaker: the woofer reproduces low frequencies and the tweeter reproduces high frequencies. Similarly in the YIG oscillator, the main coil allows large, slow changes in frequency but cannot respond to high frequency deviations, which are sent to the faster–acting FM coils.

The tune current from the A11 phase lock assembly splits into two paths. One path is lowpass filtered, removing high frequency components, and goes to the YIG main coil; the other path is highpass filtered, removing low frequency components, and goes to the YIG FM coils. The filters are matched in stop–band response, such that one picks up where the other leaves off.

The full YIG oscillator frequency range is achieved in two bands:

Band	Frequency Range
Low	50 MHz – 2.55 GHz
Mid	2.55 GHz – 20 GHz
High	20 GHz – 40 GHz

In the low band, the 2.55 to 20 GHz output of YIG1 and the fixed 3.8 GHz output of the A57 fixed oscillator are mixed in the A53 mixer/amplifier assembly. In this band, S2 and S3 switch A53 into the circuit.

The mid band uses the output of YIG1.

The high band uses the output of YIG2.

In the A58 M/D/S microcircuit, the YIG oscillator signal is modulated by the ALC OUT signal (explained below) to provide power control and leveling.

ALC: Automatic Leveling Control

A portion of the source output is detected in the M/D/S and sent back to the source Interface Board ALC circuit. This circuit generates a control signal which is sent to the modulator in the M/D/S to control the power.

SIGNAL SEPARATION

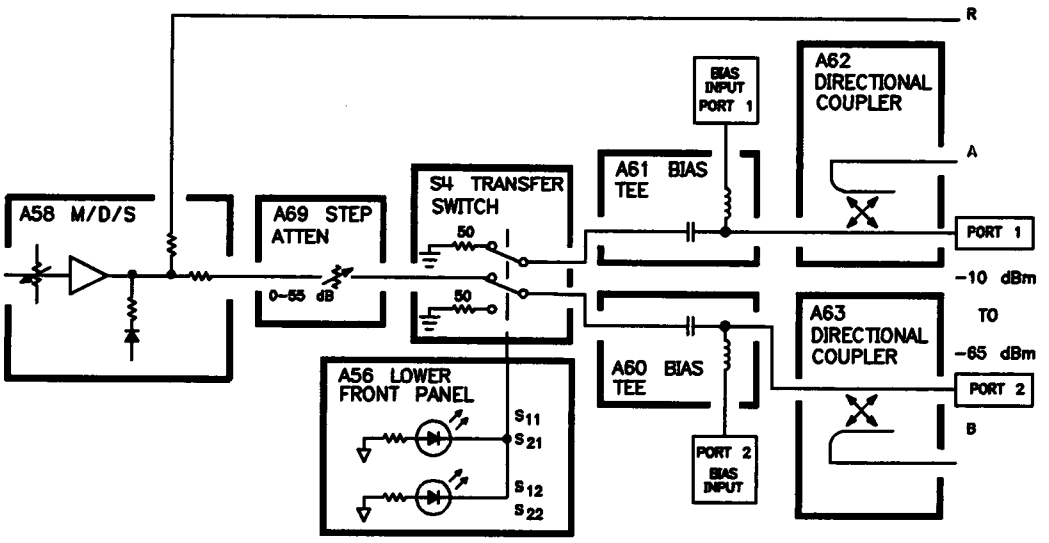


Figure 15–6. Signal Separation, Simplified Block Diagram

A58 M/D/S Modulator, Detector, Splitter

The M/D/S microcircuit accomplishes four separate functions. The modulator controls the output power proportionally to the signal produced by the ALC circuit on the source Interface board. The detector outputs a voltage that is proportional to the RF power out of the amplifier. This voltage is used by the ALC circuit on the source Interface board.

The power source divides the source signal into two parts. One signal is routed directly to the A64 R sampler and the other is sent through the A69 step attenuator, S4 transfer switch, A60 and A61 bias tees, A62/A63 directional couplers and to the test ports.

The M/D/S microcircuit is controlled by the ALC circuitry on the source interface board. The CPU provides fine control of the test port power for applications such as power sweep.

A69 Step Attenuator

The step attenuator provides coarse power control for the source signal. It is an electro–mechanical attenuator, controlled by the A9 CPU, that provides 0 to 55 dB of attenuation in 5 dB steps. It adjusts the power level to the DUT without changing the level of the incident power in the reference path.

S4 Transfer Switch

The output of the step attenuator is fed into the transfer switch S4. This is a coaxial electro–mechanical switch with very low loss. It switches between the port 1 and port 2 measurement paths, automatically enabling alternate forward and reverse measurements. In addition, S4 provides an internal termination for the measurement port that is inactive.

A56 Lower Front Panel Assembly

The A56 lower front panel assembly provides an interface for the transfer switch control voltages, and for the DC voltage from the rear panel to the bias tees. LEDs on the lower front panel indicate the status of the transfer switch.

A60 and A61 DC Bias Tees

The DC bias tees provide a means of biasing active devices with an external DC voltage connected to the rear panel DC BIAS CONNECT ports. The DC voltage is applied directly to the center conductor of the test port connectors. A blocking capacitor ensures that the bias current goes only to the device under test, and not back into the source. Likewise, an inductor in the bias path prevents RF from being imposed on the external DC supply.

A62 and A63 Directional Couplers

The test signal goes into the through–line arm of the couplers, and from there to the test ports (–15 dBm to —65 dBm) and the device under test. The coupled arm of the couplers carries the signal reflected from or transmitted through the device under test to the receiver for measurement. The coupling coefficient of the directional couplers is nominally 20 dB (40 dB at 50 MHz).

RECEIVER THEORY

The receiver measures and processes the input signals into digital information for display on the CRT. Figure 15–7 is a simplified block diagram of the receiver functional group. The A12 reference assembly, which is part of the source group, is also included in the illustration to show how the 2nd LO signal is derived.

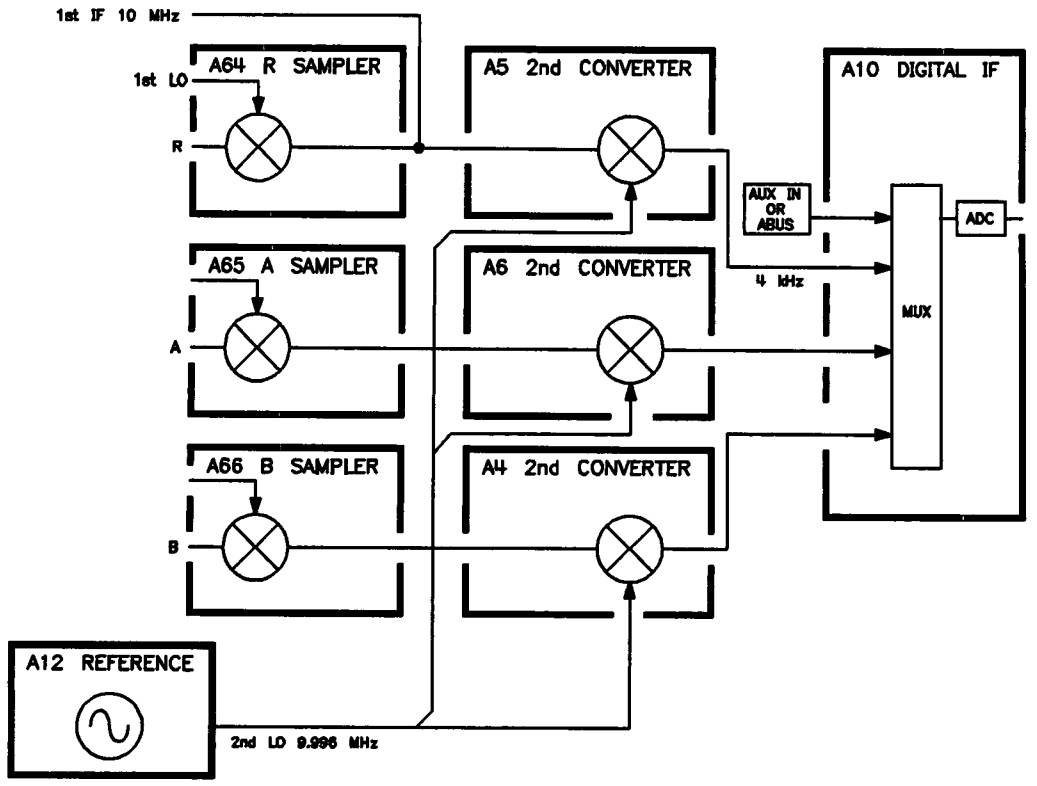


Figure 15–7. Receiver Functional Group, Simplified Block Diagram

Samplers and Second Converters

Each input signal goes to one of three identical pairs of sampler and second converter assemblies (R, A, and B) that down–convert the signals to a fixed 4 kHz 2nd IF with magnitude and phase corresponding to the input.

The 1st LO Signal is a comb of harmonics of the synthesizer signal, produced by a step recovery diode in the A52 pulse generator. Refer to *Source Group Theory* for details.

A64/A65/A66 Samplers. The signal from the source is mixed with the 1st LO harmonics in the samplers. One of the harmonic signals is 10 MHz above the desired frequency. The mixing products are filtered, leaving only the difference between that harmonic and the source frequency: this fixed 10 MHz signal is the 1st IF ($F_{IF} = N \times F_{VCO} - F_S$, where N is the harmonic number). Part of the 1st IF signal from the R sampler is fed back to the A11 phase lock assembly to complete the source phase–locked loop. The 1st IF from all three samplers goes to the corresponding second converters.

2nd LO Signal. The stable 2nd LO signal is produced in the A12 reference assembly by phase locking and mixing a 39.984 MHz VCO with the 40 MHz VCXO to derive a difference of 16 kHz. This is compared to a 16 kHz reference produced by dividing 40 MHz by 2500. The phase–locked output of the 39.984 MHz oscillator is divided by 4 to provide the 9.996 MHz 2nd LO.

A4/A5/A6 Second Converters. The 1st IF and the 2nd LO are mixed in the second converter. The resulting difference frequency is a constant 4 kHz 2nd IF signal that retains the amplitude and phase characteristics of the measured signal. The 2nd IF signals from all three second converter assemblies are input to the A10 digital IF assembly.

A10 Digital IF

In this assembly, the 2nd IF signals from the A and B second converters go through a gain stage. Signals lower than —30 dB on these two signal paths are amplified by 24 dB to ensure that they can be detected by the ADC (analog–to–digital converter). For troubleshooting purposes, the gain can be forced on or off using the service menus (refer to the *Receiver* tab in the troubleshooting section.) The R path signal is fixed at a level high enough to maintain phase lock, and therefore requires no amplification.

All three signals are sampled at a 16 kHz rate set by a divided–down 4 MHz clock pulse from the A12 reference assembly. The signals are sequentially multiplexed into the ADC, where they are converted to digital form. The ADC conversions are triggered by timing signals from the CPU or the synthesizer, or an external signal at the rear panel EXT TRIG connector. The digitized data is serially clocked into the A9 CPU assembly to be processed into magnitude and phase data. The processed and formatted data is finally routed to the CRT for display, and to the HP–IB for remote operation. Refer to *Digital Control Theory* in this section and to *Data Processing* in the first chapter of the *Reference* for more information on signal processing.

An additional input to the A10 assembly is the analog bus (ABUS), a built–in service tool for testing analog circuits within the instrument. This is a single multiplexed line that networks analog nodes throughout the instrument, or monitors an external input at the rear panel AUX INPUT connector. It is controlled by the CPU, and used like an oscilloscope or frequency counter to make internal voltage and frequency measurements.

REPLACEABLE PARTS

Chapter 16. Replaceable Parts

INTRODUCTION

This section contains information for ordering replaceable parts for three instruments. The replaceable parts include major assemblies, chassis hardware, but not parts of major assemblies (except as noted). Table 16–1 lists major reference designations and abbreviations used in the parts lists.

Refer to the "Replacement Procedures" section of this manual for hints on removing and replacing assemblies.

ADJUSTMENTS AND VERIFICATION

Adjustments or verification procedures or both may be required to assure that the analyzer meets its published specifications following replacement of an assembly. "Post Repair Procedures" lists such requirements.

R–E (REBUILT–EXCHANGE) ASSEMBLIES COST LESS

Lower cost assemblies are available through the rebuilt–exchange program. These factory *rebuilt* (repaired and tested) assemblies meet all factory specifications required of a new assembly. They are offered on an *exchange* (trade–in) basis only. The defective assembly must be returned for credit, so R–E assemblies are not suitable for stock or spares. Figure 16–1 illustrates the rebuilt–exchange procedure. Figure 16–2 shows all major assemblies, including those that can be replaced on an exchange basis.

If you have any questions, contact your HP customer engineer.

REPLACEABLE PARTS LIST

The following figures assist in location and identification of all replaceable parts, including corresponding lists that provide the following information:

1. Hewlett–Packard part number.
2. Part quantity as shown in the corresponding figure. There may or may not be more of the same part located elsewhere in the instrument.
3. Part description, using abbreviations in Table 16–1.

ORDERING INFORMATION

To order a part listed in the replaceable parts lists, quote the Hewlett–Packard part number, indicate the quantity required, and address the order to the nearest Hewlett–Packard office.

To order a part that is not listed in the replaceable parts lists, include the instrument model number, complete instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett–Packard office.

How to Order Parts ... Fast!

When you know which parts you need to repair the instrument, contact Hewlett–Packard's direct ordering team by calling the following toll–free number:

(800) 227–8164
Monday through Friday, 6 am to 5 pm (Pacific Standard Time)

The parts specialists have direct online access to replacement parts inventory corresponding to the *Replaceable Parts* list in this manual. There is a charge for hotline one day delivery, but four day delivery time is standard. After hours and holidays, call (415) 968–2347.

This information applies to the United States only. Outside the United States, contact your nearest HP office.

Table 16–1. Reference Designations and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS

A ..... Assembly
CR . Diode, Diode Thyristor, Step Recovery Diode (SCR), Varactor
DS Annunciator, Lamp, Light Emitting Diode (LED), Signaling Device
F ..... Fuse
FL ..... Filter
J ..... Electrical Connector (Stationary Portion), Jack
MP ..... Miscellaneous Mechanical Part
P ..... Electrical Connector (Movable Portion), Plug
Q ..... Silicon Controlled Rectifier (SCR), Transistor, Triode Thyristor
R ..... Resistor
S ..... Switch
TP ..... Test Point
U ..... Integrated Circuit
W ..... Cable, Transmission Path, Wire

ABBREVIATIONS

A

ADJ ..... Adjust, Adjustment
AMP ..... Amplifier
ASSY ..... Assembly
ATTN ..... Attenuator

B

BD ..... Board
BNC .... Type of Connector

C

C ... Capacitance, Capacitor
CBL ..... Cable
CHAM ..... Chamfer
CPU Central Processing Unit

D

D .. Deep, Depletion, Depth, Diameter, Direct Current
DB .. Decibel, Double Break
DBL ..... Double

E

EXT .. Extended, Extension, External, Extinguish

F

F Fahrenheit, Farad, Female, Film (Resistor), Fixed, Flange, Flint, Fluorine, Frequency
FL ..... Flash, Flat, Fluid
FLTR ..... Filter, Floater

G

GHZ ..... Gigahertz

H

HD ..... Hand, Hard, Head, Heavy Duty
HEX ..... Hexadecimal, Hexagon, Hexagonal

I

ID ..... Identification, Inside Diameter
IN ..... Inch, Indium
INTL ..... Internal

K

KB ..... Knob

L

LED .. Light Emitting Diode
LG ..... Length, Long
LKWR ..... Lockwasher

M

MACH ..... Machine
MM ..... Millimeter
MTLC ..... Metallic

N

NEG ..... Negative

O

OD ..... Olive Drab, Outside Diameter

P

PAN–HD ..... Pan Head
PC ..... Picocoulomb, Piece, Printed Circuit
PNL ..... Panel
P/O ..... Part of
PN ..... Part Number

Table 16–1. Reference Designations and Abbreviations (2 of 2)

R

R ..... Rear
RFI ..... Radio Frequency Interference

S

SAMP ..... Sampler
SCR ..... Screw, Scrub, Silicon Controlled Rectifier
SHFT ..... Shaft
SHLDR ..... Shoulder
SKT ..... Skirt, Socket
SLDR ..... Solder
SMB ..... Subminiature, B Type (Snap–On Connector)
SST ..... Stainless Steel

T

THD .... Thread, Threaded
THK ..... Thick

V

VDC .. Volts, Direct Current

W

W ..... Watt, Wattage, White, Wide, Width, Wire

X

XSTR ..... Transistor

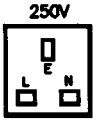
Y

YIG . Yttrium–iron–garnet

Z

ZN–P ..... Zinc Plate

Table 16–2. Power Cable and Plug Part Numbers

PLUG TYPE [1]	CABLE HP PART NUMBER[2]	PLUG DESCRIPTION [2]	CABLE LENGTH (inches)	CABLE COLOR	FOR USE IN COUNTRY
250V 	8120–1351 8120–1703	Straight BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore
250V	8120–1369 8120–0696	Straight ZNSS198/ASC112 90°	79 87	Gray Gray	Australia, New Zealand
250V	8120–1689 8120–1692	Straight CEE7–VII 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, Republic of So. Africa, India (unpolarized in many nations)
125V	8120–1348 8120–1398 8120–1754 8120–1378 8120–1521 8120–1676	Straight NEMA5–15P 90° Straight NEMA5–15P Straight NEMA5–15P 90° Straight NEMA5–15P	80 80 36 80 80 36	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan, (100V or 200V), Mexico, Philippines, Taiwan
250V	8120–2104	Straight SEV1011.1959 24507, Type 12	79	Gray	Switzerland
250V	8120–0698	Straight NEMA6–15P			United States, Canada
220V	8120–1957 8120–2956	Straight DHCK 107 90°	79 79	Gray Gray	Denmark
250V	8120–1860	Straight CEE22–VI (System Cabinet Use)			

1. E = Earth Ground; L = Line; N = Neutral.
2. Part number for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.

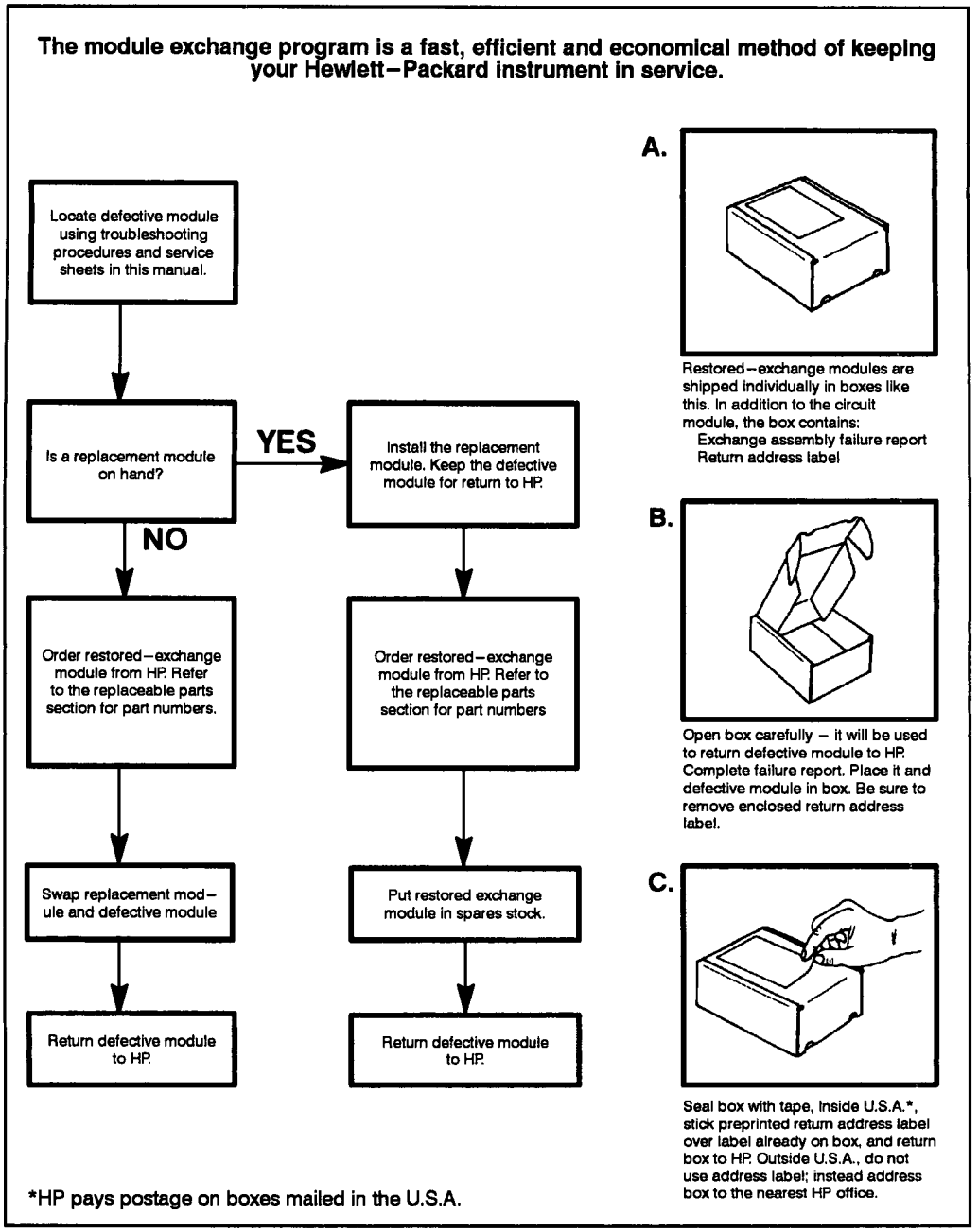

The module exchange program is a fast, efficient and economical method of keeping your Hewlett–Packard instrument in service.
Locate defective module using troubleshooting procedures and service sheets in this manual.
Is a replacement module on hand?
YES
NO
Install the replacement module. Keep the defective module for return to HP.
Order restored–exchange module from HP. Refer to the replaceable parts section for part numbers.
Order restored–exchange module from HP. Refer to the replaceable parts section for part numbers
Swap replacement module and defective module
Put restored exchange module in spares stock.
Return defective module to HP.
Return defective module to HP.
*HP pays postage on boxes mailed in the U.S.A.
A.
Restored–exchange modules are shipped individually in boxes like this. In addition to the circuit module, the box contains:
Exchange assembly failure report
Return address label
B.
Open box carefully – it will be used to return defective module to HP. Complete failure report. Place it and defective module in box. Be sure to remove enclosed return address label.
C.
Seal box with tape. Inside U.S.A.*, stick preprinted return address label over label already on box, and return box to HP. Outside U.S.A., do not use address label; instead address box to the nearest HP office.

Figure 16–1. The Low–cost Rebuilt–Exchange Procedure

Ref. Desig	HP Part Number	Qty	Description
A1	08720-60087	1	FRONT PANEL KEYBD ASSY
A2	08753-60091	1	FRONT PANEL INTERFACE BD ASSY
A3			NOT ASSIGNED
A4, A5, A6	08415-60004	3	SECOND CONVERTER
A7			NOT ASSIGNED
A8	08722-60011	1	POST-REGULATOR BD ASSY
A8F1	2110-0425	3	FUSE 2A 125V NTD .25X.27
A8F2	2110-0424	2	FUSE .75A 125V NTD .25X.27
A8F3	2110-0425		FUSE 2A 125V NTD .25X.27
A8F4	2110-0424		FUSE .75A 125V NTD .25X.27
A8F5	2110-0476	2	FUSE 4A 125V NTD .25X.27
A8F6	2110-0425		FUSE 2A 125V NTD .25X.27
A8F7	2110-0476		FUSE 4A 125V NTD .25X.27
A8F8	2110-0047	1	FUSE 1A 125V NTD .25X.27
A8F9	2110-0046	1	FUSE .5A 125V NTD .25X.27
A9	08722-60003	1	CPU BD ASSY-8722A ONLY
A9	08722-69003		CPU BD ASSY (R-E)-8722A ONLY
A9	08722-60016	1	CPU BD ASSY-8722C ONLY
A9	08722-69016		CPU BD ASSY (R-E)-8722C ONLY
A10	08753-60095	1	DIGITAL IF BD ASSY
A10	08753-69095		DIGITAL IF BD ASSY (R-E)
A11	08722-60053	1	PHASE LOCK BD ASSY
A11	08722-69053		PHASE LOCK BD ASSY (R-E)
A12	08720-60012	1	REFERENCE BD ASSY
A12	08720-69012		REFERENCE BD ASSY (R-E)
A13	08720-60049	1	FRACTIONAL N ANALOG BD ASSY
A13	08720-69049		FRACTIONAL N ANALOG BD ASSY (R-E)
A14	08720-60050	1	FRACTIONAL N DIGITAL BD ASSY
A14	08720-69050		FRACTIONAL N DIGITAL BD ASSY (R-E)
A15	08753-60098	1	PREREGULATOR ASSY
A15	08753-69098		PREREGULATOR ASSY (R-E)
A15F1	2110-0655	1	FUSE-3.15A 250V
A16	08720-60044	1	REAR PANEL BD ASSY
A17	08720-60051	1	(MOTHERBD ASSY (INCLUDES MOTHERBD RIVETED TO CAGE ASSY AND FRAME)
A18	2090-0210	1	DISPLAY ASSY
A18	5180-8484		DISPLAY ASSY (R-E)
A19	08753-60170		GRAPHICS SYSTEM PROCESSOR ASSY

Figure 16-2. Major Assemblies (1 of 4)

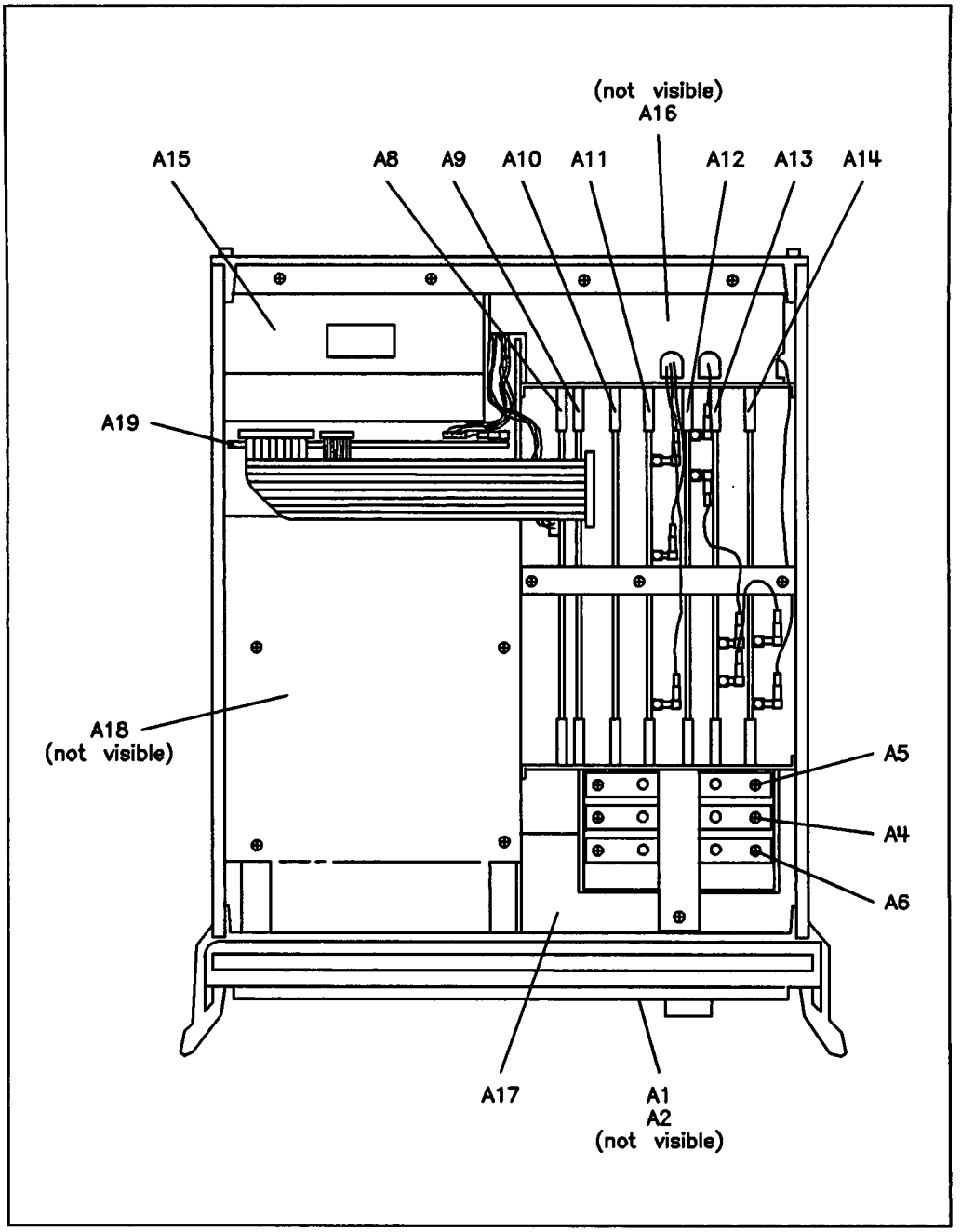


Figure 16–2. Major Assemblies (2 of 4)

Ref. Desig	HP Part Number	Qty	Description
A51	08722-60005	1	TEST SET INTERFACE BD ASSEMBLY
A52	5086-7456	1	PULSE GENERATOR (INCLUDES BIAS BD)
A52	5086-6456		PULSE GENERATOR (R-E) (INCLUDES BIAS BD-NOT SEPARATELY REPLACEABLE).
A53	5086-7583	1	LOWBAND MICROCIRCUIT
A53	5086-6583		LOWBAND MICROCIRCUIT (R-E)
A54	08722-60013	1	YIG 20 - 40 GHZ
A55	08720-60082	1	YIG 1 2.4 - 20 GHz
A56	08722-60004	1	LOWER FRONT PANEL BD ASSEMBLY
A57	08720-60073	1	FIXED OSCILLATOR 3.8 GHZ
A58	5086-7590	1	M//D/S MICROCIRCUIT-8722A ONLY
A58	5086-6590	1	M//D/S MICROCIRCUIT (R-E)-8722A ONLY
A58	5086-7615	1	M/A/D/S MICROCIRCUIT-8722C ONLY
A58	5086-6615	1	M/A/D/S MICROCIRCUIT (R-E)-8722C ONLY
A59	08720-60052	1	SOURCE INTERFACE BOARD
A60, A61	5086-7484	2	BIAS TEE
A60, A61	5086-6484		BIAS TEE (R-E)
A62, A63	5086-7518	2	DIRECTIONAL COUPLER
A64, A65, A66	5086-7614	3	SAMPLER
A64, A65, A66	5086-6614		SAMPLER (R-E)
A67/68			NOT ASSIGNED
A69	33326-60006	1	STEP ATTENUATOR
Q1	1826-0423	1	IC REGULATOR
S1	5086-7589	1	40 GHZ SWITCH
S2, S3	08415-60057	2	MICROWAVE SWITCH
S4	08722-60015	1	TRANSFER SWITCH (STACK OF 3 W/LOADS AND CABLES)
S4	08722-69015	1	TRANSFER SWITCH R-E

Figure 16-2. Major Assemblies (3 of 4)

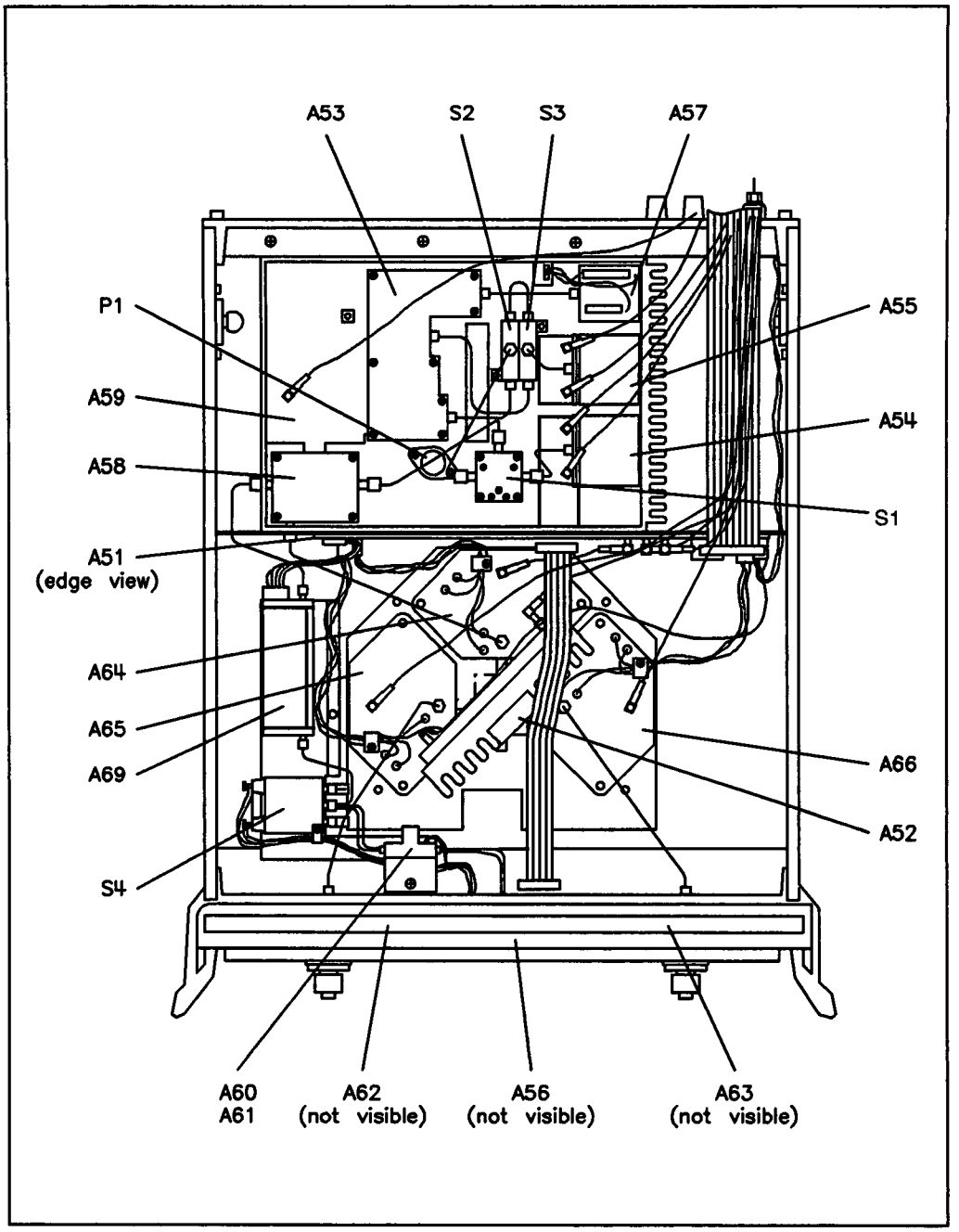
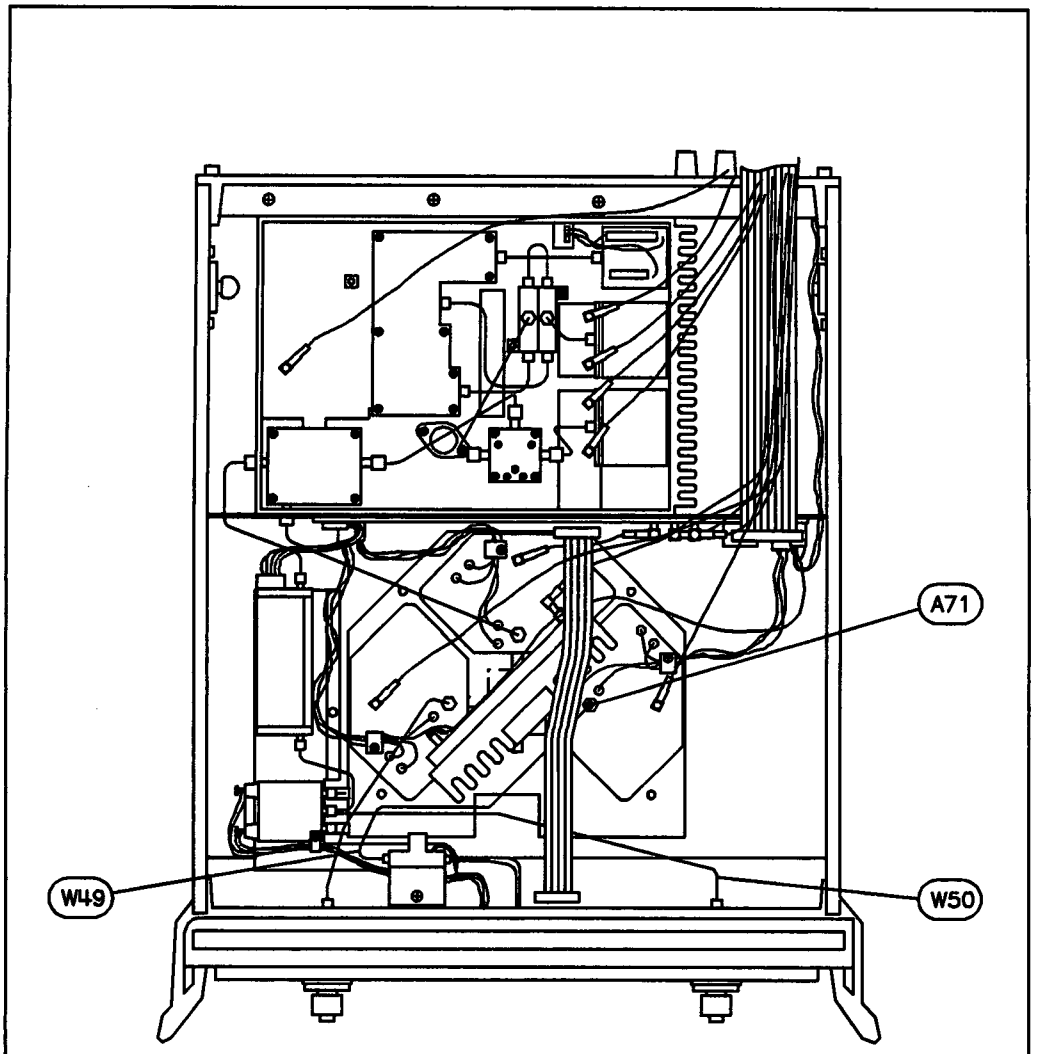
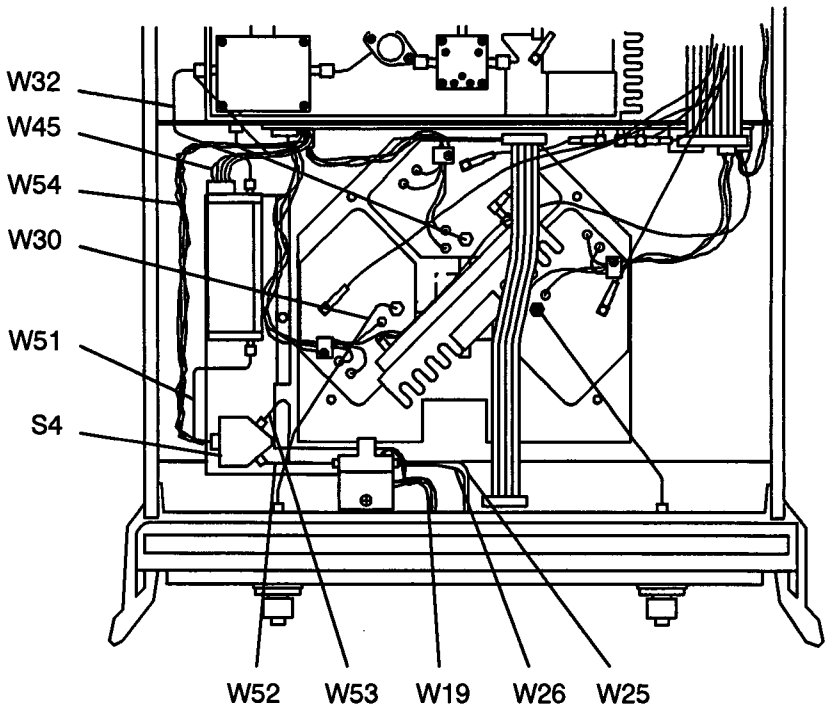


Figure 16–2. Major Assemblies (4 of 4)



Ref. Desig	HP Part Number	Qty	Description
W49	08722-20032	1	CABLE, SEMI-RIGID BIAS TEE TO A71 (OPTION 003 ONLY)
W50	08722-20033	1	CABLE, SEMI-RIGID PORT 2 COUPLER TO SR (OPTION 003 ONLY)
A71	08516-60021	1	ATTENUATOR 6 dB FIXED (OPTION 003 ONLY)

Figure 16-3. Option 003



Ref. Desig	HP Part Number	Qty	Description
S4	85331-60033	1	SOLID STATE SWITCH (OPTION 006 ONLY)
W51	08722-20095	1	CABLE S5 TO A69 (OPTION 006 ONLY)
W52	08722-20094	1	CABLE S5 TO A61 (OPTION 006 ONLY)
W53	08722-20093	1	CABLE S5 TO A60 (OPTION 006 ONLY)
W54	08340-60122	1	CABLE S5 TO A51 (OPTION 006 ONLY)

Figure 16–4. Option 006

Ref. Desig	HP Part Number	Qty	Description
W1	08722-20014	1	CABLE S2 TO S3
W3	08722-20015	1	CABLE S2 TO S1
W5	08722-20017	1	CABLE S1 TO A58
W6	08720-20061	1	CABLE A53 TO S3
W7	08720-20063	1	CABLE A55 TO S3
W11	08720-20065	1	CABLE A57 TO A53
W22	08722-20013	1	CABLE A63 TO A66
W23	08722-20031	1	CABLE A58 TO A64
W25	08722-20006	1	CABLE A62 TO A61
W26	08722-20007	1	CABLE A63 TO A60
W27	08722-20009	1	CABLE A60 TO S4
W28	08722-20008	1	CABLE A61 TO S4
W29	08722-20011	1	CABLE S4 TO A69
W30	08722-20012	1	CABLE A62 TO A65
W32	08722-20018	1	CABLE A69 TO A58
W42	08720-20068	1	CABLE S2 TO A53
W43	08722-20016	1	CABLE A54 TO S1
W44	08722-20010	2	CABLE S4 INTERCONNECT

Figure 16-5. Semi-Rigid RF Cables (1 of 2)

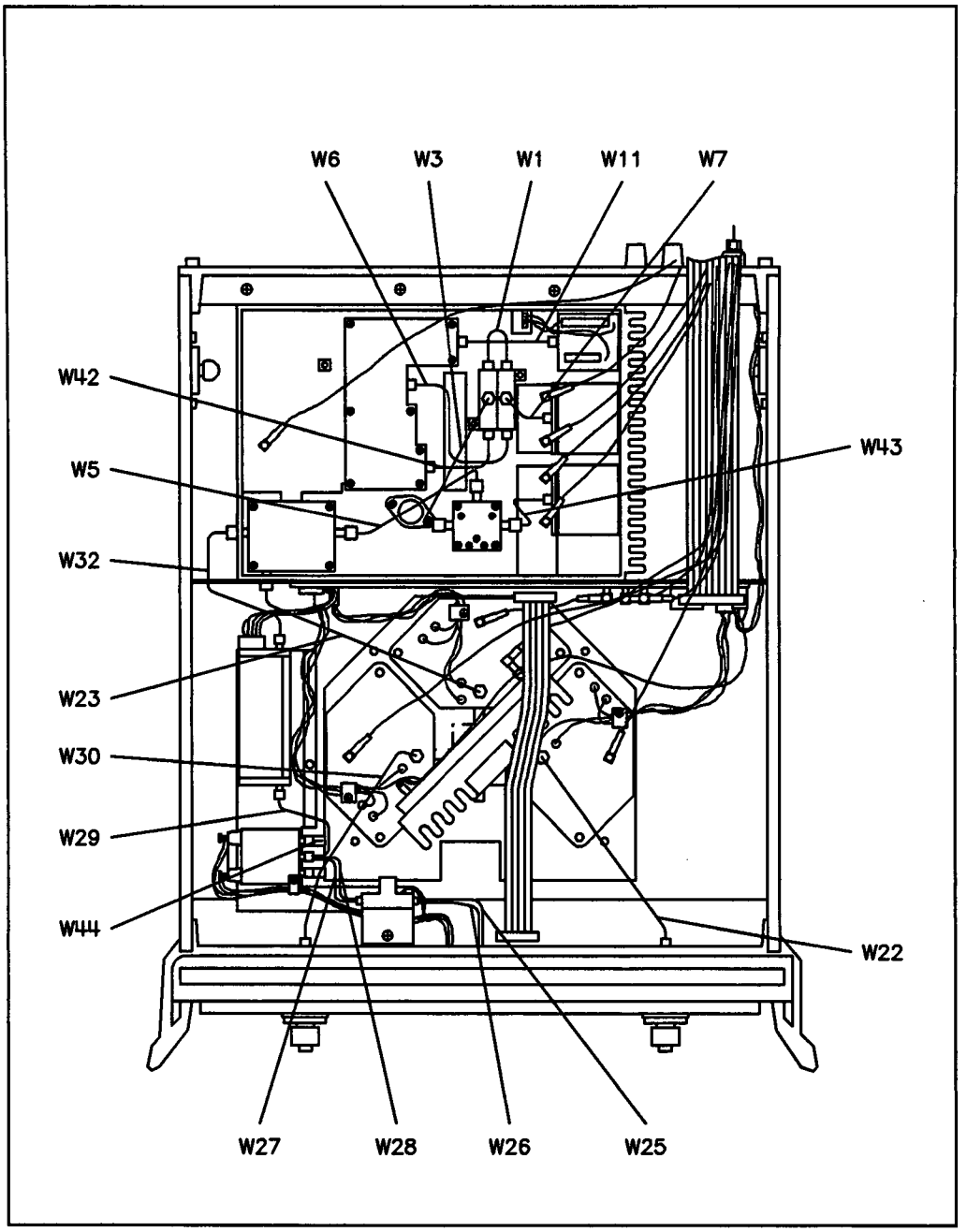


Figure 16–5. Semi–Rigid RF Cables (2 of 2)

Ref. Desig	HP Part Number	Qty	Description
W10	08415-60031	1	FLEXIBLE RF CABLE A55 TO A11
W12	08720-60038	1	CABLE ASSEMBLY A57 TO A59
W13	08415-60030	1	FLEXIBLE RF CABLE A55 TO A17
W14	08720-60074	1	RIBBON CABLE ASSEMBLY A51 TO A17
W15	08720-60077	1	FLEXIBLE RF CABLE A51 TO A17
W16	08720-60076	1	FLEXIBLE RF CABLE A51 TO A11
W17	08513-60023	1	CABLE ASSEMBLY A66 TO A51
W18	08415-60028	1	FLEXIBLE RF CABLE A66 TO A17
W19	08722-60007	1	CABLE ASSEMBLY A56 TO A60/A61/S4
W20	08720-60084	1	CABLE ASSEMBLY A52 TO A51
W21	08415-60027	1	FLEXIBLE RF CABLE A65 TO A17
W24	08722-60006	1	CABLE ASSEMBLY A56 TO A51
W31	08415-60035	1	FLEXIBLE RF CABLE A52 TO A14
W34	08720-60075	1	FLEXIBLE RF CABLE A64 TO A51
W35	08513-60023	1	CABLE ASSEMBLY A65 TO A51
W36	08513-60023	1	CABLE ASSEMBLY A64 TO A51
W37	08720-60071	1	CABLE ASSEMBLY REAR PANEL TO A51
W45	5062-0701	1	CABLE ASSEMBLY A69 TO A58
W46	08415-60032	1	CABLE ASSEMBLY A54 TO A14

Figure 16-6. Flexible Cable Assemblies (1 of 4)

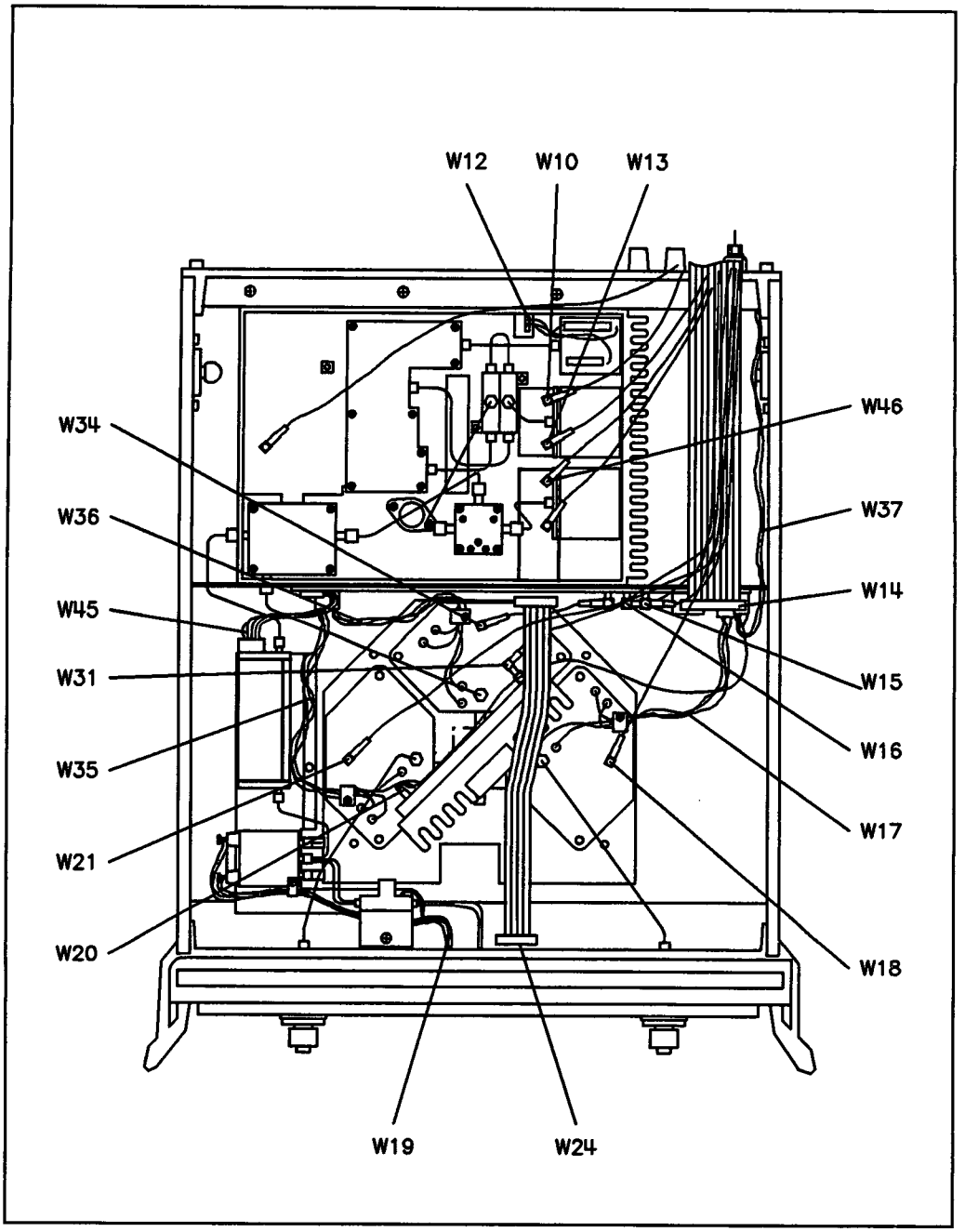


Figure 16–6. Flexible Cable Assemblies (2 of 4)

Ref. Desig	HP Part Number	Qty	Description
W2	08513-60036	1	RIBBON CABLE ASSEMBLY A15 TO 19
W4	08753-60113	1	CABLE ASSEMBLY A19 TO A8
W8	08415-60040	1	FLEXIBLE RF CABLE A12 TO A13
W9	08415-60041	1	FLEXIBLE RF CABLE A13 TO A14
W38			See Figure 16-8
W39			See Figure 16-8
W40			See Figure 16-8
W41			See Figure 16-8
W47	08415-60033	1	CABLE ASSEMBLY A11 TO A54
W48			See Figure 16-8

Figure 16-6. Flexible Cable Assemblies (3 of 4)

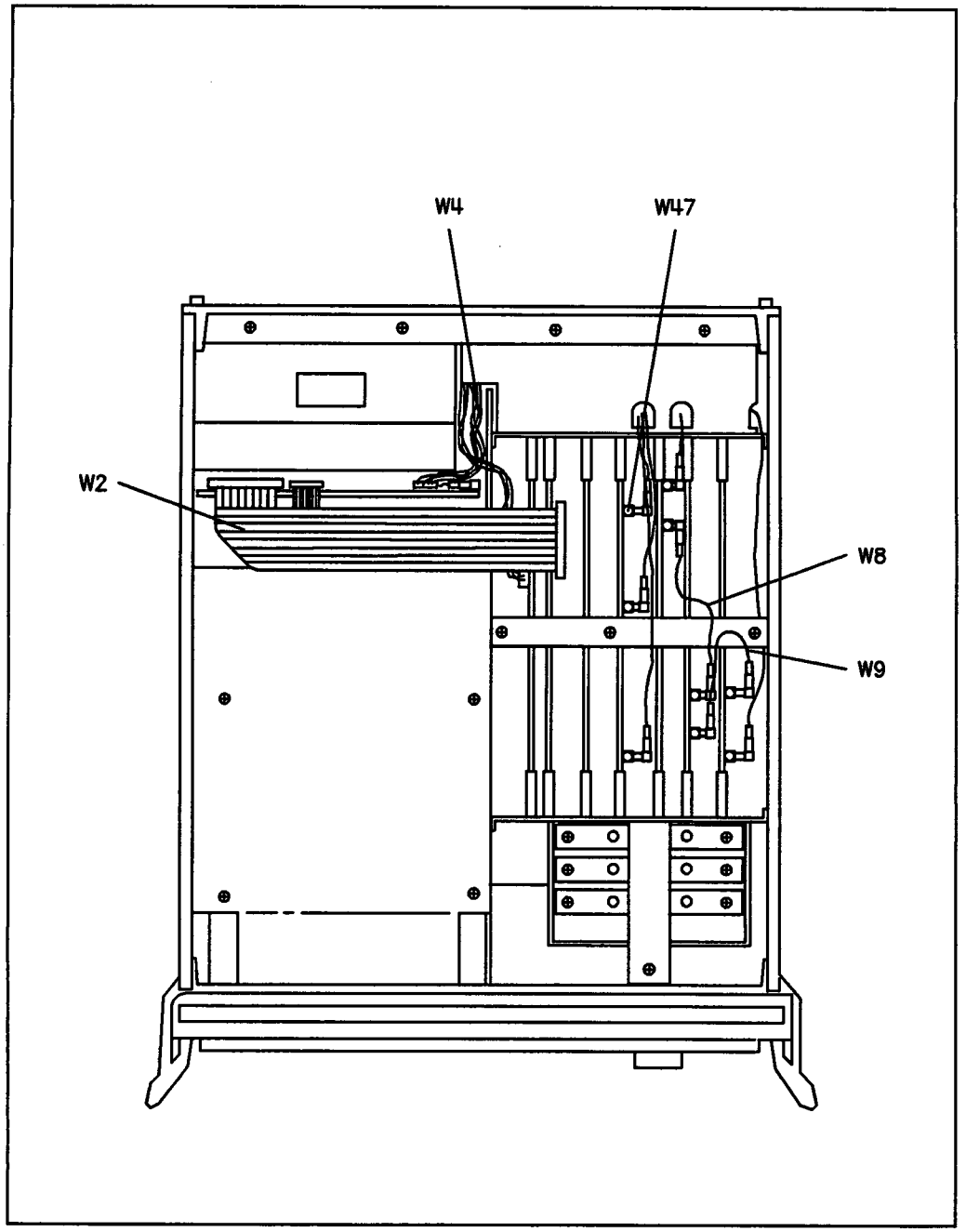


Figure 16–6. Flexible Cable Assemblies (4 of 4)

Ref. Desig	HP Part Number	Qty	Description
1	08757-40005	1	LINE SWITCH KEY
	1460-1573	1	SPRING-EXT .138-IN-OD SST PSVT
	08753-00048	1	LINE SWITCH ACTUATOR
	08753-00036	1	SWITCH INSULATOR
2	08720-80034	1	FRONT DRESS PANEL-UPPER
3	01650-47401	1	KNOB-BASE
	2190-0016	1	WASHER-LK INTL T 3/8 IN .377-IN-ID
	2950-0043	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK
4	5021-3427	2	WASHER-TEST PORT CONNECTOR
	5021-3428	2	NUT FLANGE-TEST PORT
	08517-60027	2	CONNECTOR KIT -TEST PORT
5	1510-0038	1	BINDING POST ASSY SGL THD-STUD
	2190-0067	1	WASHER-LK INTL T 1/4 IN .256-IN-ID
	2950-0006	1	NUT-HEX-DBL-CHAM 1/4-32-THD .094-IN-THK
6			SCREW-MACHINE-See Figure 16-8 AND Figure 16-9
7			SCREW-MACHINE-See Figure 16-8 AND Figure 16-9
8*	0515-2113	2	SCREW-MACH 4.0 X 0.7 8 MML
13	08757-40012	1	SOFTKEYS COVER
14	08722-60002		DISPLAY BEZEL ASSEMBLY

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-7. Front Panel Miscellaneous Parts (1 of 4)

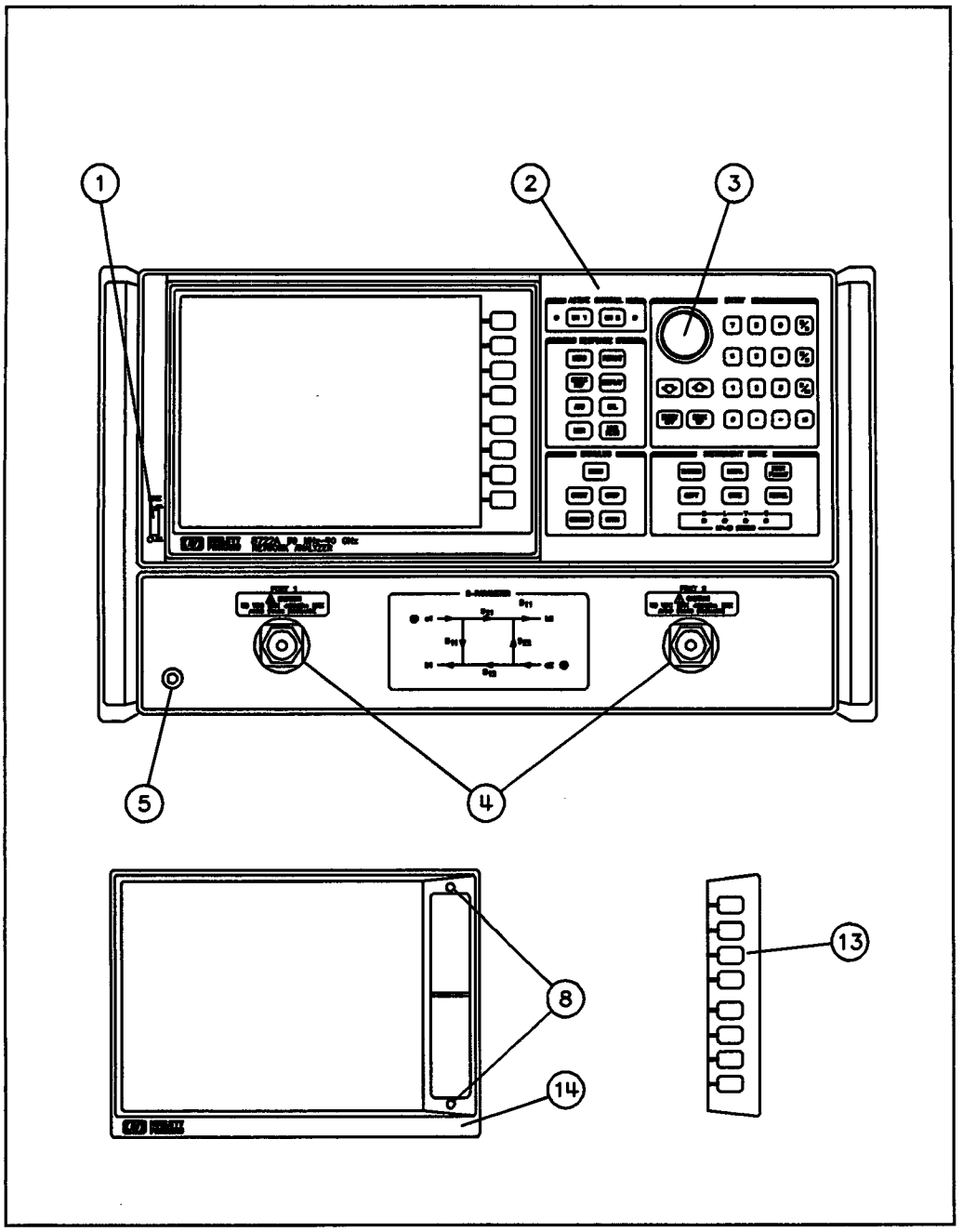


Figure 16–7. Front Panel Miscellaneous Parts (2 of 4)

Ref. Desig	HP Part Number	Qty	Description
6	0515-2086		SCREW-MACHINE-See Figure 16-8 AND Figure 16-9
7	0515-2086		SCREW-MACHINE-See Figure 16-8 AND Figure 16-9
8*	0515-2113	2	SCREW-MACH M4.0 X 0.7 8MM-LG PAN-HD
W43	08753-60037		RIBBON CABLE ASSY-A17J1/A2
9*	0515-0374	8	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD
11*	0515-0375	4	SCREW-MACH M3 X 0.5 20MM-LG PAN-HD
12	08720-00046	1	FRONT SUB-PANEL-UPPER
13	08757-40012	1	SOFTKEYS COVER
15			SCREW-MACHINE-See Figure 16-10 AND Figure 16-11
16	08722-60008	1	FRONT DRESS PANEL-LOWER
17	08722-00002	1	FRONT SUB-PANEL-LOWER
18	0535-0031	5	NUT 3.0 MM
19*	0515-0374	4	SCREW-MACH M3 X 0.5 8MM-LG PAN-HD
21	08757-40003	1	SUPPORT-BEZEL
22	0515-2086		SCREW-MACHINE-See Figure 16-10
23	08720-40008	1	KEYPAD, RUBBER
24	08720-60070	1	KEYPAD BD ASSY
25	1990-1525	1	ROTARY PULSE GENERATOR

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-7. Front Panel Miscellaneous Parts (3 of 4)

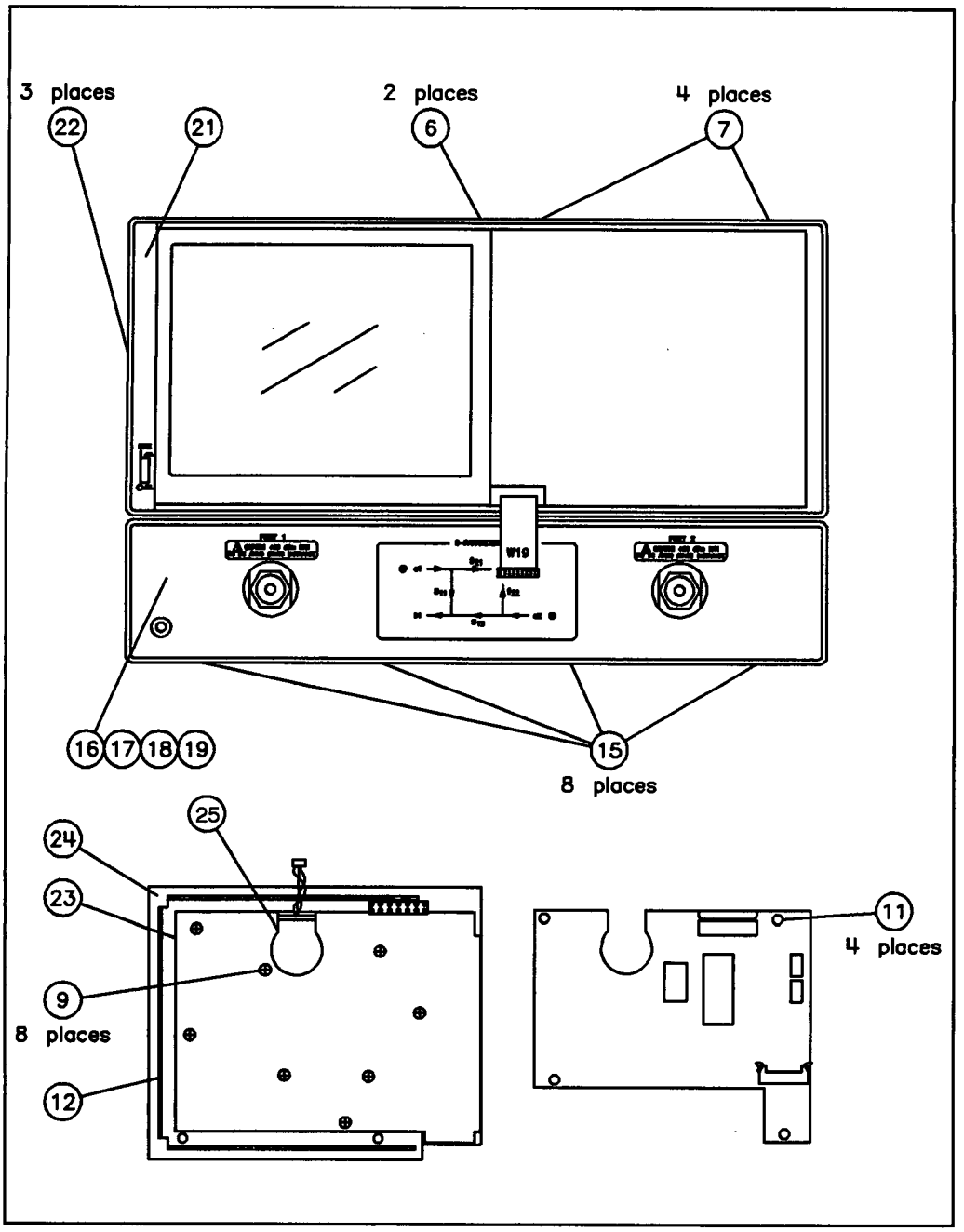


Figure 16–7. Front Panel Miscellaneous Mechanical Parts (4 of 4)

Ref. Desig	HP Part Number	Qty	Description
1	1400-0110	2	FUSEHOLDER-BIPIN SKT 5A 125 V
	1400-0112	2	FUSEHOLDER CAP FOR USE WITH H-P P/N
	2110-0046	2	FUSE .5A 125V NTD .25X.27
	2190-0016	2	WASHER-LK INTL T 3/8 IN .377-IN-ID
2	2190-0016		WASHER-LK INTL T 3/8 IN .377-IN-ID
	2950-0001	2	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK
	1250-0083	2	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM
3	0360-1632	1	TERMINAL-SLDR LUG LK-MTG FOR-#3/8-SCR
4	1251-2942	2	SCREW LOCK KIT-SUBMIN D CONN
5	2190-0102	7	WASHER-LK INTL T 15/32 IN .472-IN-ID
	2950-0035	7	NUT-HEX-DBL-CHAM 15/32-32-THD
7	2190-0586	2	LK WASHER
8			SCREW-MACHINE - See Figure 16-9
9*	0515-0372	3	SCREW-MACH M3 X 0.5 8MM-LG
10			SCREW-MACHINE - See Figure 16-9
11	3150-0484	1	AIR FILTER, GUARD, & RETAINER; 4.65 X 4.65
11*	0515-1817	4	SCREW-MACH M3.5 X 0.6 20MM-LG
12	08720-00045	1	(19C/20C) REAR PANEL
13	08415-60036	1	FAN-TUBE AXIAL (INCLUDES CABLE ASSY)
W38	8120-5401		FLEXIBLE CABLE ASSY, EXT AM
W39	08753-60117		FLEXIBLE CABLE ASSY, RED
W40	08753-60118		FLEXIBLE CABLE ASSY, BLUE
W41	08753-60118		FLEXIBLE CABLE ASSY, GREEN
W48	08753-60026	1	FLEXIBLE RF CABLE ASSEMBLY - EXT REF

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-8. Rear Panel Miscellaneous Parts (1 of 3)

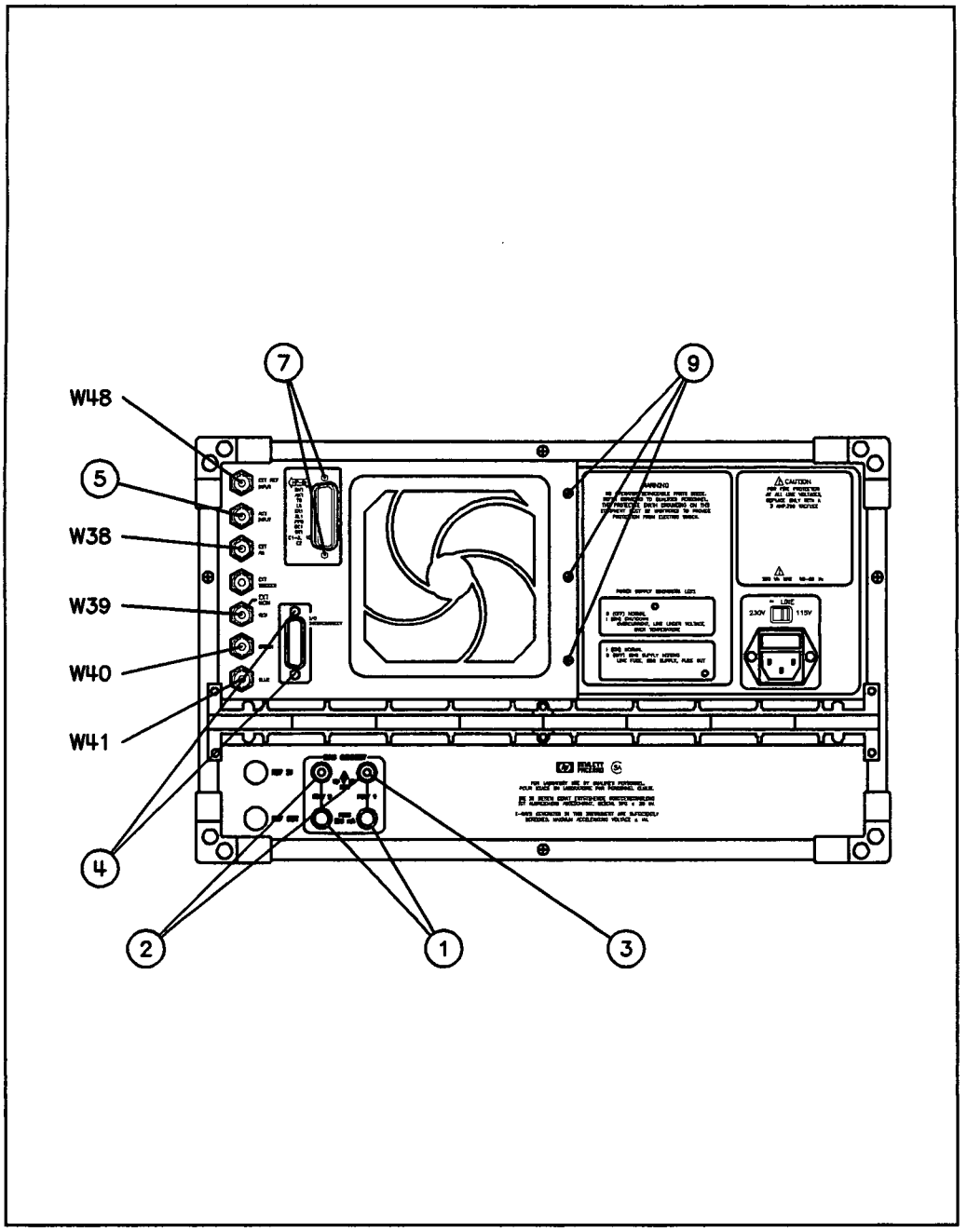


Figure 16–8. Rear Panel Miscellaneous Parts (2 of 3)

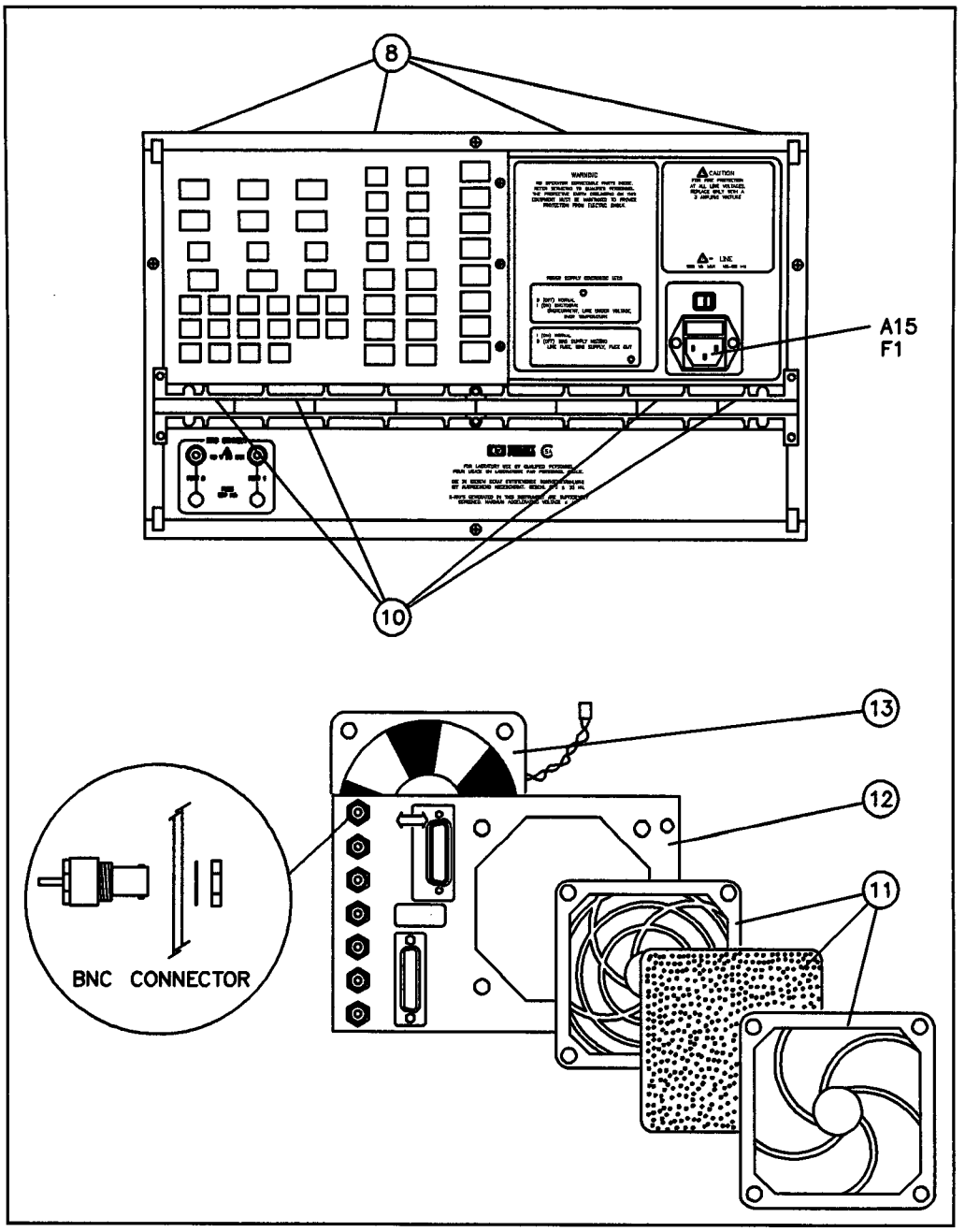


Figure 16–8. Rear Panel Miscellaneous Parts (3 of 3)

Ref. Desig	HP Part Number	Qty	Description
A8F1			FUSE – See Figure 16–2
A8F2			FUSE – See Figure 16–2
A8F3			FUSE – See Figure 16–2
A8F4			FUSE – See Figure 16–2
A8F5			FUSE – See Figure 16–2
A8F6			FUSE – See Figure 16–2
A8F7			FUSE – See Figure 16–2
A8F8			FUSE – See Figure 16–2
A8F9			FUSE – See Figure 16–2
1*	0515–0433	4	5MM 4 X 0.7 8MM PNTX
3*	0515–0458	6	SCREW–MACHINE ASSY M3.5 X 0.8 MML
4*	0515–2035	1	SCREW–MACH M3 X 0.5 16MM–LG
5	08753–20062	1	STABILIZER CAP
	08753–40005	1	PC BD STABILIZER
5*	0515–0374	2	SCREW–MACH M3 X 0.5 10MM–LG PAN–HD
6	08720–00009	1	CAN HOLDDOWN
	08720–40004	3	LOCATOR HOLDDOWN
7	08415–40001	1	CAN GUIDE–PLASTIC
8*	0515–0458	1	SCREW–MACH M3.5 X 0.6 8MM–LG PAN–HD
10*	0515–2086	3	SCREW–METRIC SPECIALTY M4 X 0.7 THD; 7 MML

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16–9. Miscellaneous Mechanical Parts – Display Processor (1 of 4)

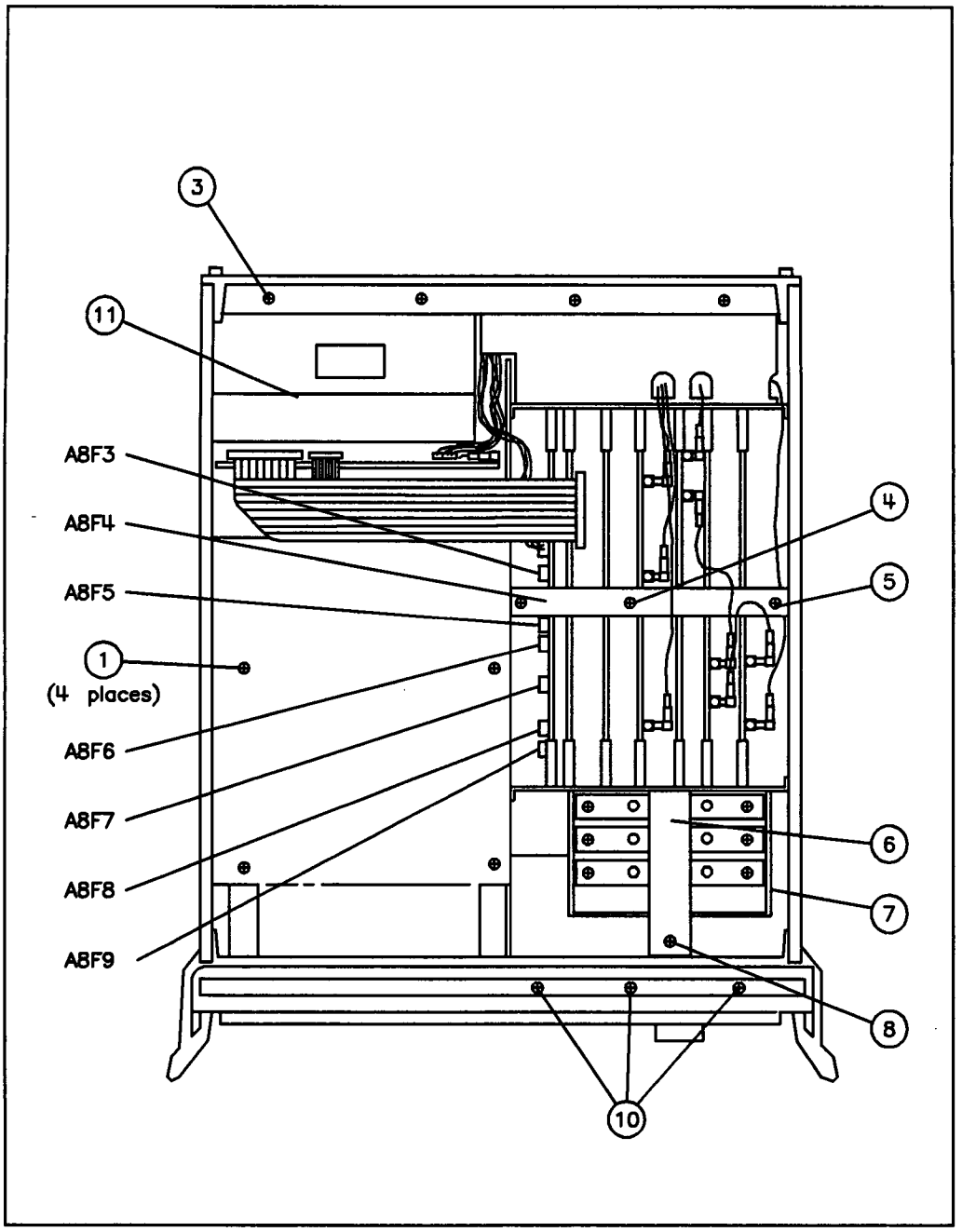


Figure 16–9. Miscellaneous Mechanical Parts – Display Processor (2 of 4)

Ref. Desig	HP Part Number	Qty	Description
A17			MOTHERBOARD – See Figure 16–2
1*	0515–2086	3	SCREW–MACH M4.0 X 0.7 7 MMLC
2	5041–7250	3	CABLE CLIP
3*	0515–1091	4	SCREW–MACHINE ASSY M3.5 X 0.6
4	1390–0661	2	FASTENER–SNAP–IN BALL STUD 10 MM BALL
4*	2190–0669	2	WASHER–LK HLCL 8.0 MM 8.1–MM–ID
7	08753–20046	3	INSULATION–CABLE
8	08720–20022	1	HINGE HALF

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16–9. Miscellaneous Mechanical Parts – Display/Processor (3 of 4)

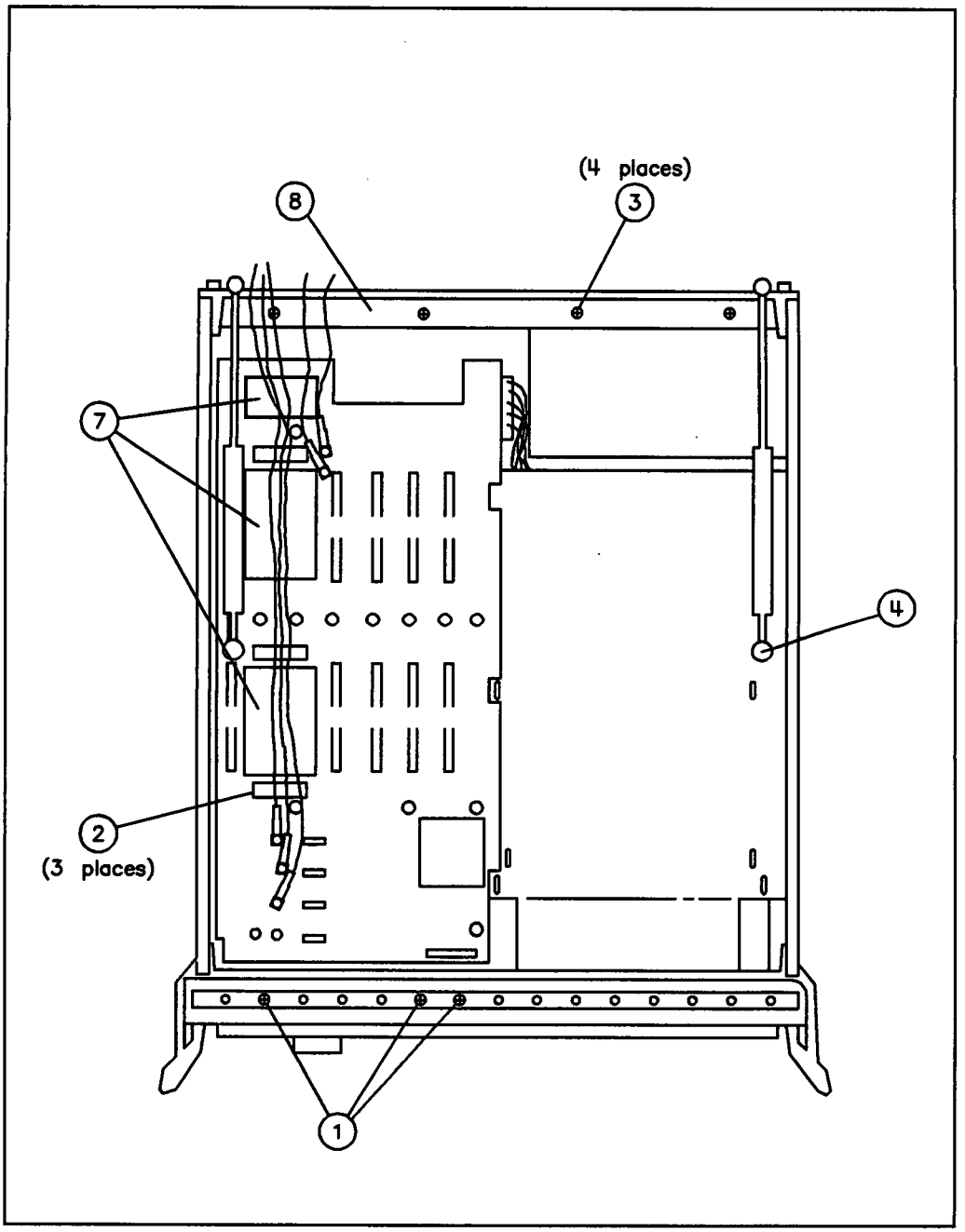


Figure 16–9. Miscellaneous Mechanical Parts – Display Processor (4 of 4)

Ref. Desig	HP Part Number	Qty	Description
1	08720-20069	1	HINGE HALF
	08720-20027	1	HINGE PIN
2*	0515-0451	4	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD
3*	0515-1349	2	SCREW-MACH M3 X 0.5 30MML
	0515-0430	2	SM M3 X 0.5 6MM-LG PN-HD
4	08720-00039	2	MOUNTING BRACKET
5	08720-20015	1	HEATSINK/RF CAGE
6	0515-0666	4	MACHINE SCREW
8*	0515-0377	3	MACHINE SCREW
9	2360-0242	2	MACHINE SCREW
10	2360-0117	4	MACHINE SCREW
13	08720-00026	1	DECK-FRONT
16	08722-00003	1	MOUNTING BRACKET-S4/A60/A61, ATTENUATOR
22*	0575-0433	4	SCREW-MACH M4 X 0.7 8MM-LG PAN-HD
	3050-0893	4	
25	08415-00061	2	BRACKET-GAS SPRING BALL
	1530-0387	2	GAS SPRING
	1390-0661	2	BALL STUD
	2190-0669	2	WASHER-LK HLCL 8.0 MM 8.1-MM-ID
26*	0515-1400	4	SCREW-MACH M3.5 X 0.6 8MM-LG
27*	0515-2011	4	SCREW-MACHINE ASSY M3.5 X 0.6
28	08720-20023	2	ALIGNMENT ARM
29	0515-0380	2	SCREW-MACH M4 X 0.7 10MM-LG PAN-HD

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-10. Miscellaneous Mechanical Parts Test Set (1 of 2)

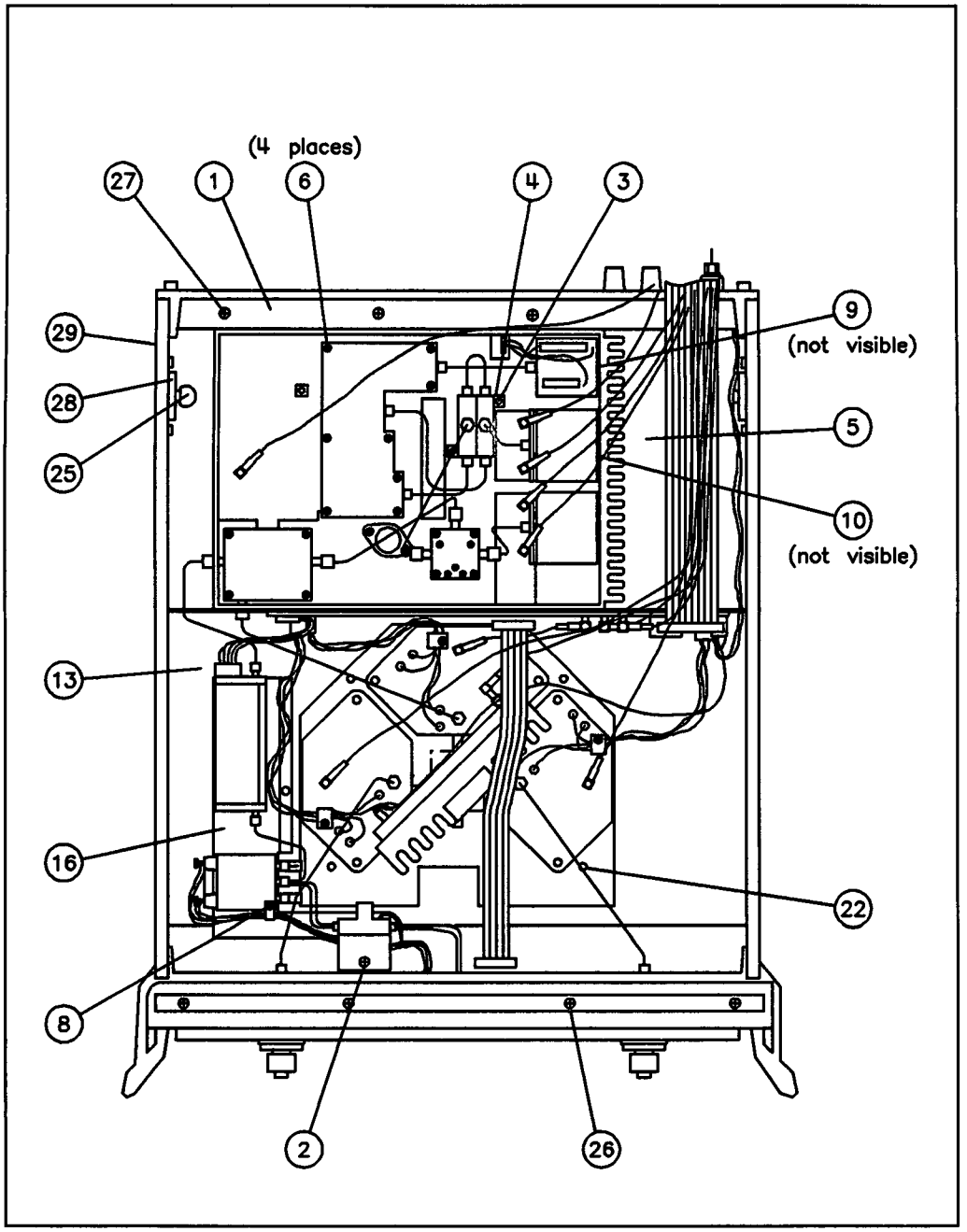
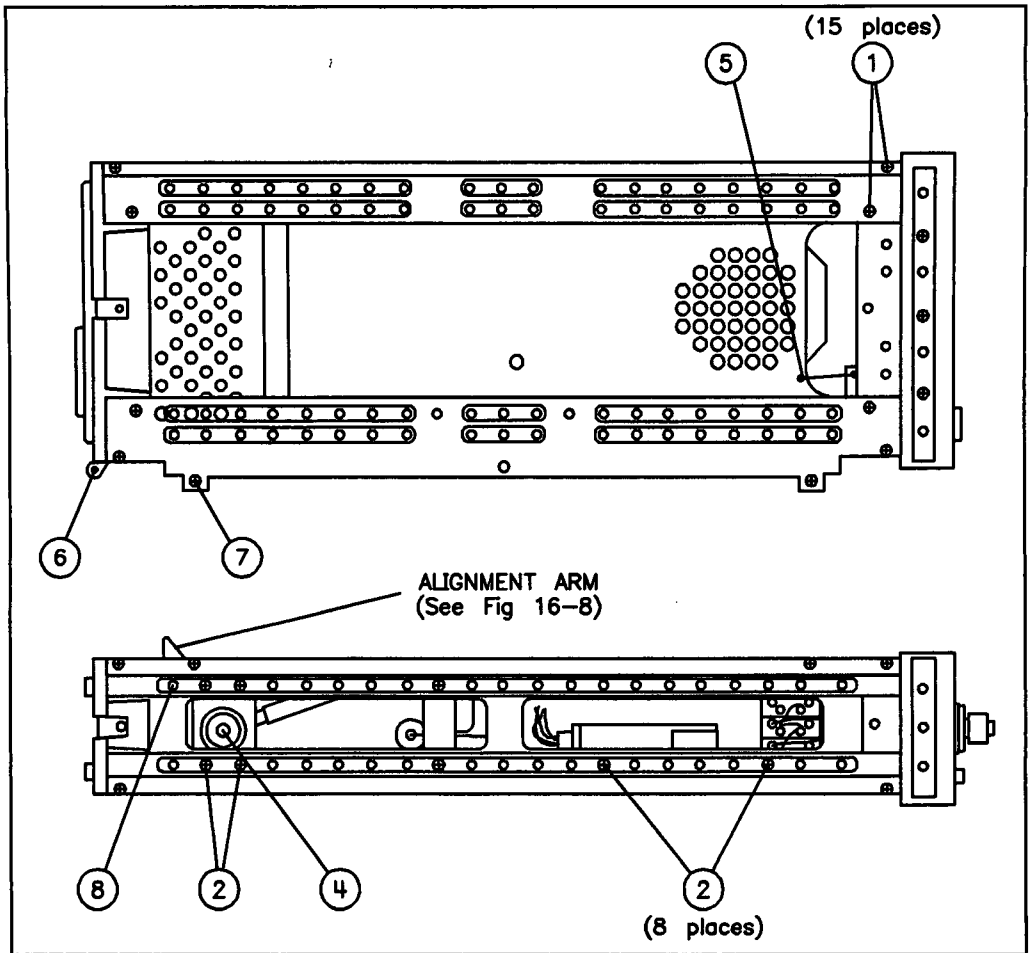


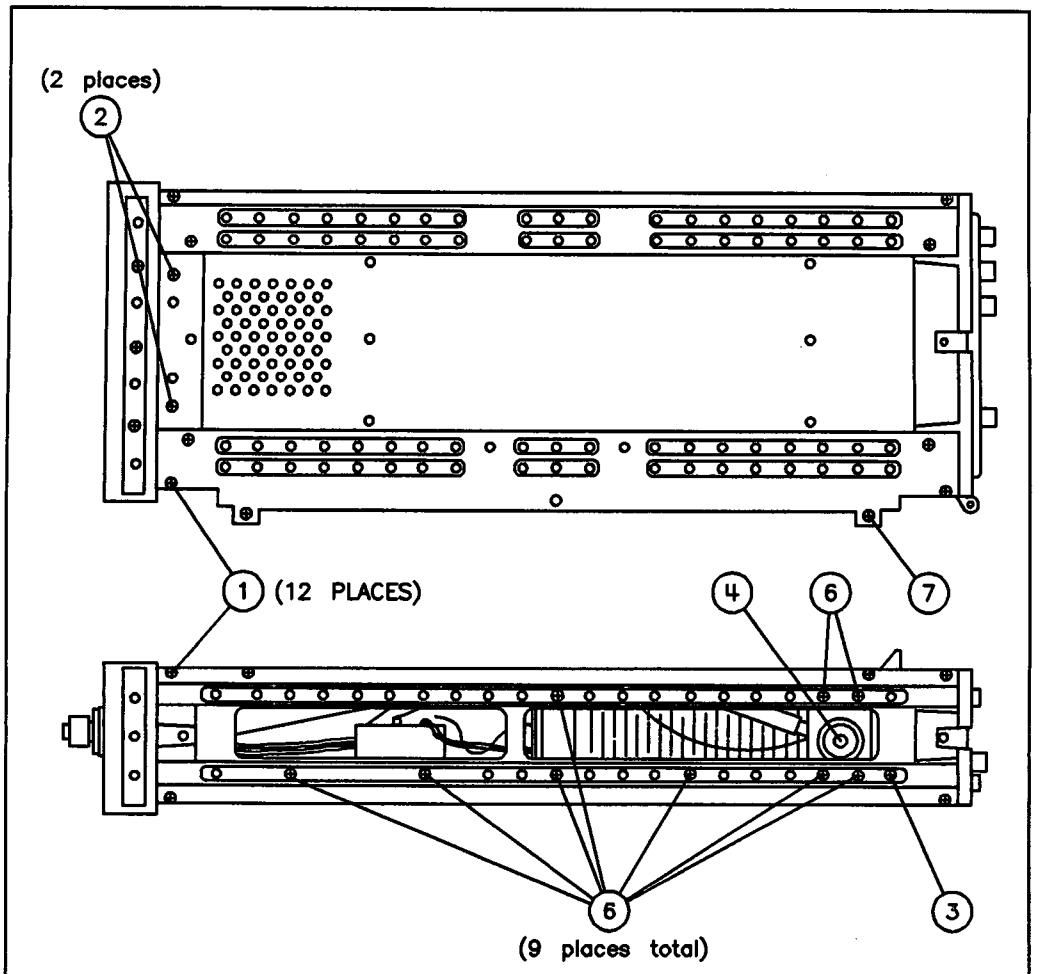
Figure 16–10. Miscellaneous Mechanical Parts Test Set (2 of 2)



Ref. Desig	HP Part Number	Qty	Description
1*	0515-2086	15	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6
2*	0515-0377	8	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD
4*	2190-0669	1	WASHER-LK HLCL 8.0 MM 8.1 MM-ID
	08415-00061	1	BRACKET-GAS SPRING BALL
	1390-0661	1	FASTENER-SNAP-IN BALL STUD 10 MM BALL
5	1460-1573		SPRING .138 OD - See Figure 16-6
6			HINGE PIN - See Figure 16-10
7	0515-0431	2	SCREW-MACH M3.5 X 0.6 4MM-LG PAN-HD
8	0515-0380	2	MACHINE SCREW

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-11. Left Side View



Ref. Desig	HP Part Number	Qty	Description
1*	0515-2086	12	SCREW-METRIC SPECIALTY M4 X 0.7 THD; 6
2*	0515-1402	2	SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD
4*	2190-0669	1	WASHER-LK HLCL 8.0 MM 8.1 MM-ID
	08415-00061	1	BRACKET-GAS SPRING BALL
	1390-0661	1	FASTENER-SNAP-IN BALL STUD 10 MM BALL
6	0515-0377	8	MACHINE SCREW
7	0515-0431	2	MACHINE SCREW

* CAUTION:This hardware is metric. Use of other thread types is likely to damage threaded holes.

Figure 16-12. Right Side View

Ref. Desig	HP Part Number	Qty	Description
1	5062-3735	1	COVER-TOP (47)*
2	5021-5806	1	REAR FRAME-UPPER
3	5021-5802	1	REAR FRAME-LOWER
4	08720-00015	1	COVER-RIGHT SIDE (47)*
4	08720-00016	1	COVER-LEFT SIDE (47)*
5	5062-3992	1	FRONT HANDLE KIT (46)*
	0515-1132	12	HANDLE SCREWS
6	1460-1345	2	TILT STAND
7	5041-8801	4	FOOT-BOTTOM
8	5062-3747	1	COVER-BOTTOM (47)*
9	5041-8802	1	TRIM TOP
10	5021-8401	1	FRONT FRAME-LOWER (46)*
11	5021-8405	1	FRONT FRAME-UPPER (46)*
12	5021-5837	2	SIDE STRUT-UPPER TOP CORNER
13	5021-5961	2	SIDE STRUT-UPPER BOTTOM CORNER
14	5021-5887	2	SIDE STRUT-LOWER
15	5041-8821	4	REAR PANEL STANDOFF
16	5062-3802		SINGLE REPLACEMENT FRONT HANDLE (46)*
17	5021-8499		HANDLE TRIM STRIP
			TOUCH-UP PAINT
46	6010-1146		Dove Gray Touch-up Paint
47	6010-1147		French Gray Touch-up Paint
48	6010-1148		Parchment Touch-up Paint
50	6010-1150		Cobblestone Touch-up Paint

* The numbers in parenthesis in the descriptions refer to the matching touch-up paint.

Figure 16-13. Chassis Parts and Touch-up Paint (1 of 2)

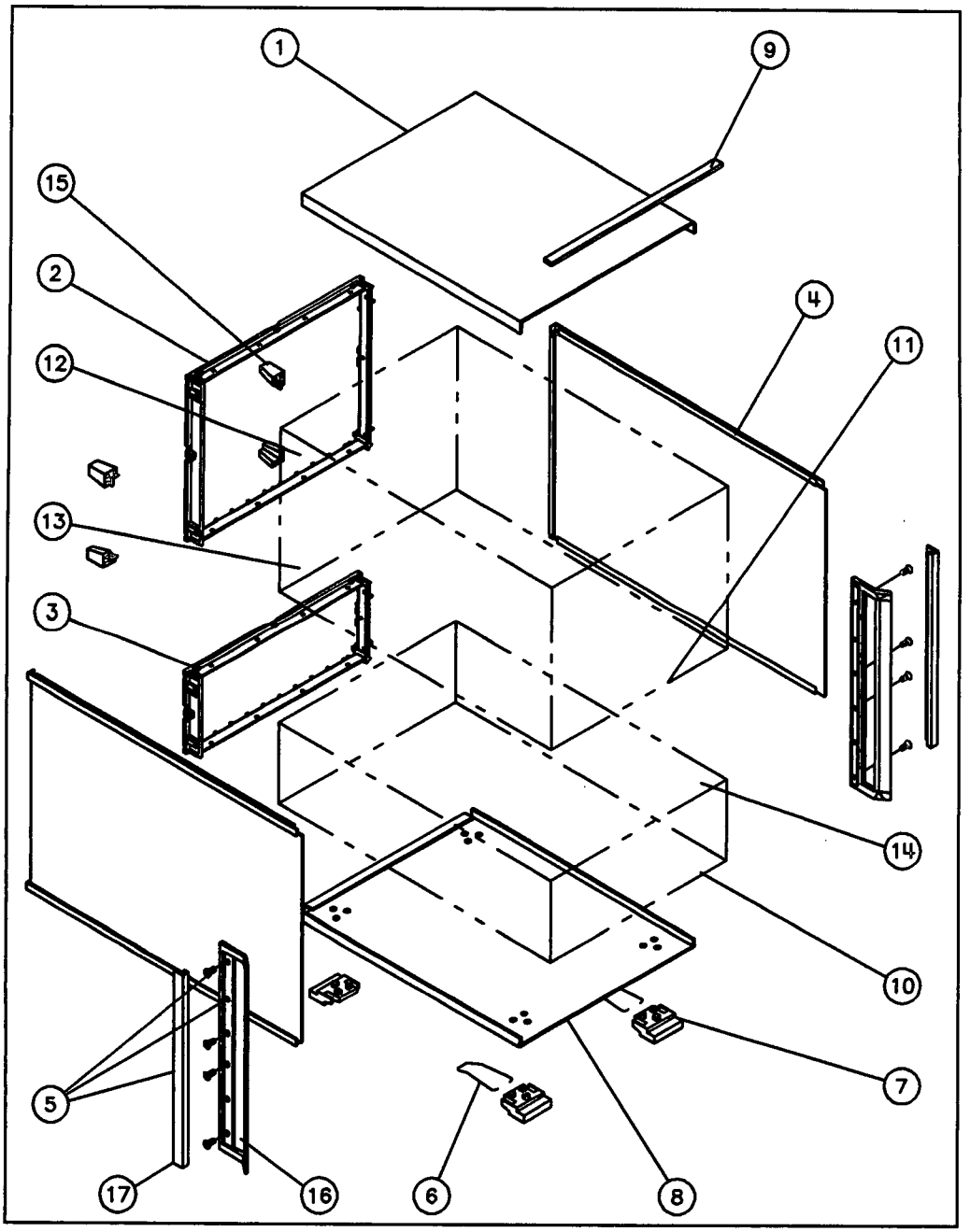
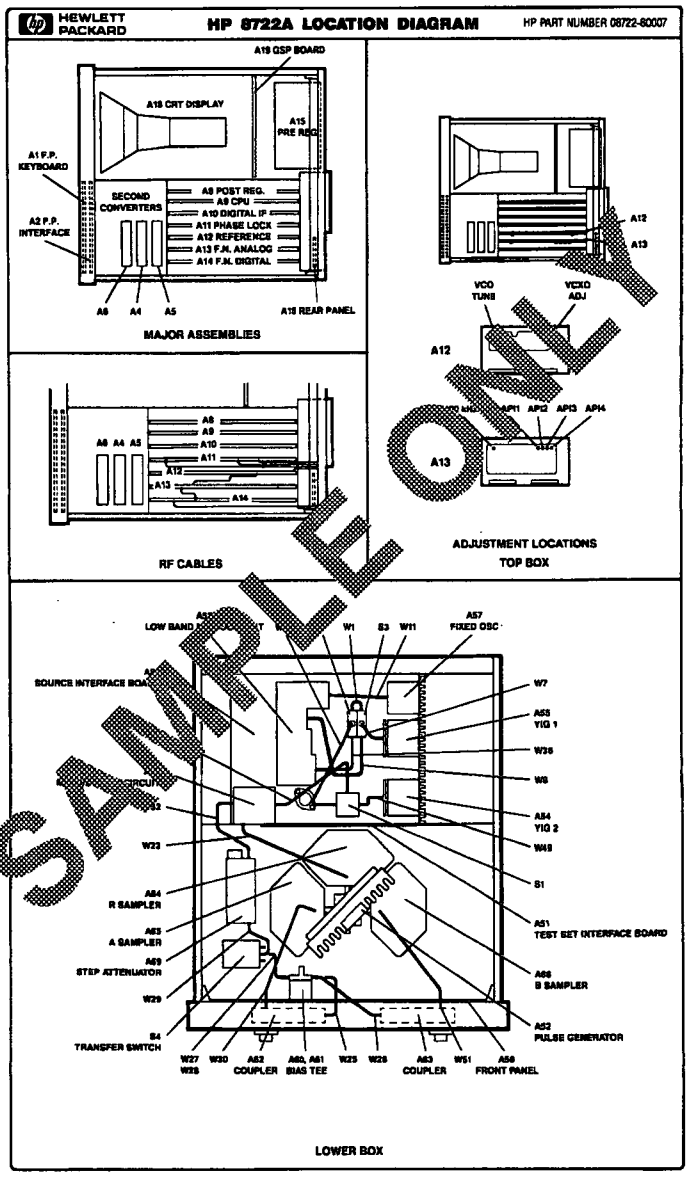


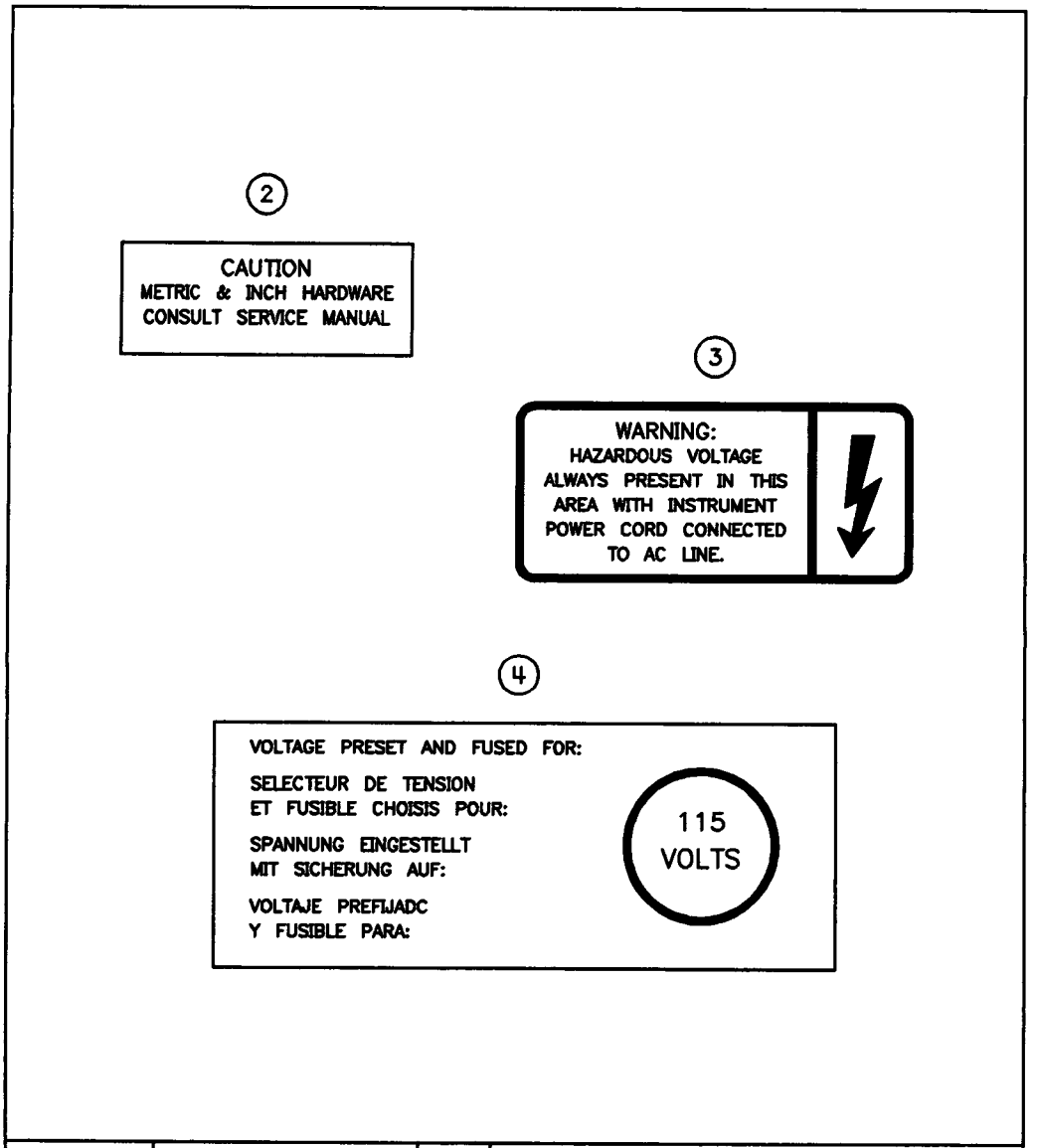
Figure 16–13. Chassis Parts and Touch–up Paint (2 of 2)



SAMPLE ONLY

Ref. Desig	HP Part Number	Qty	Description
1	08722-80007	1	LABEL – LOCATION DIAGRAM

Figure 16–14. Replaceable Labels (1 of 2)



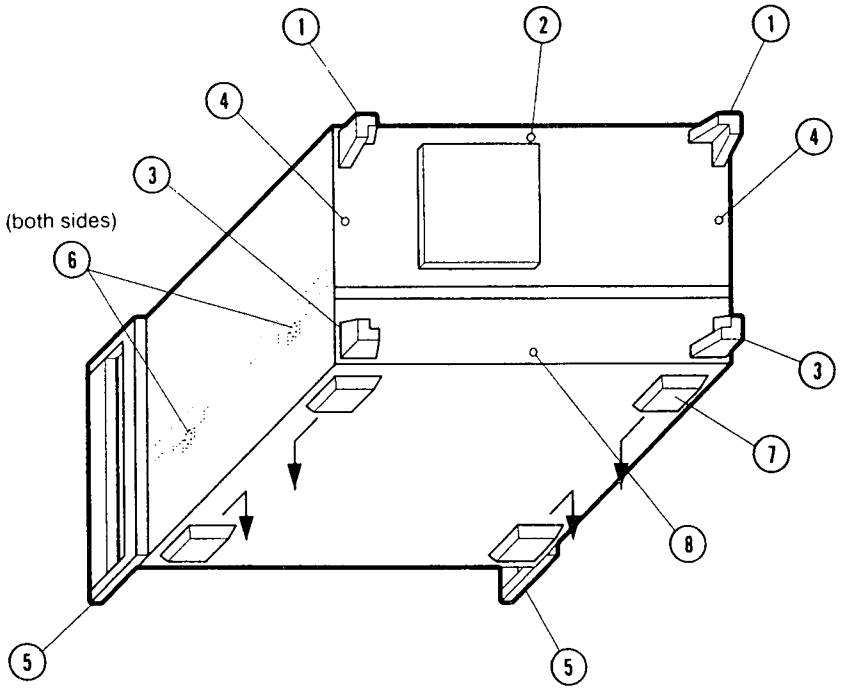
Ref. Desig	HP Part Number	Qty	Description
2	7121-2527	1	LABEL-METRIC HARDWARE CAUTION
3	7120-4295	1	LABEL-HAZARDOUS VOLTAGE WARNING
4	7120-6999	1	LABEL-LINE VOLTAGE SELECTOR SWITCH

Figure 16-14. Replaceable Labels (2 of 2)

Table 16–3. Miscellaneous Replaceable Accessories

HP Part Number	Qty	Description
		SERVICE TOOLS
08722–60018	1	TOOL KIT
		ADAPTER 2.4 mm (F) APC 3.5 (F)
		ADAPTER 2.4 mm (F) APC 3.5 (M)
		BD ASSY–EXTENDER FOR 2ND CONVERTERS
		BOARD ASSEMBLY–EXTENDER
		ADAPTER SMB (M) SMB (M)
		ADAPTER BNC (F) TO SMB (F)
		ADAPTER SMA (F) SMA (F)
		ADAPTER SMA (M) SMA (M)
		SMB TEE
		FUSE .5A 125V
		FUSE 1A 125V
		FUSE 2A 125V
		FUSE 4A 125V
		FUSE 3.15A 250V
		CABLE ASSEMBLY–EXTENDER RF
		CABLE ASSEMBLY–SMA FLEX
		WRENCH–OPEN ENDED 5.5
		BAG PLASTIC 12.0 X 15.0D
		ACCESSORIES
0955–0446	1	BANDPASS FILTER
8710–1764	1	TORQUE WRENCH 20MM 8IN–LB
		DOCUMENTATION
08722–90003	1	COMPLETE MANUAL SET
08720–90161	1	PROGRAMMING MANUAL
08720–90135	1	OPERATING MANUAL
08722–90006	1	SERVICE MANUAL
08720–90136	1	USER'S GUIDE
08720–90156	1	BASIC LANGUAGE PROGRAMMING GUIDE
08720–90155	1	HP–IB PROGRAMMING REFERENCE
08510–90064	1	CONNECTOR CARE MANUAL
5954–1566		AN326 PRINCIPLES OF MICROWAVE CONNECTOR CARE
		UPGRADE KITS
HP 86382B	1	UPGRADES AN HP 8719C TO HP 8720C
HP 86382C	1	UPGRADES AN HP 8720C TO HP 8722A
HP 86380A	1	ADDS TIME DOMAIN
HP 86381A	1	ADDS 1 HZ FREQUENCY RESOLUTION
HP 86384C	1	UPGRADES AN HP 8722C TO OPTION 006
08722–60014	1	CURRENT FIRMWARE (EPROM) 8722A ONLY
08722–60021	1	CURRENT FIRMWARE (EPROM) 8722C ONLY

Cover Removal



To remove top cover:

- remove upper rear feet (1)
- loosen screw (2)
- slide cover off

To remove left side cover:

- remove top cover
- remove lower rear foot (3)
- remove screws (4) and handle (5)
- loosen screw (6)
- slide cover back

To remove right side cover:

- remove top cover
- remove lower rear foot (7)
- loosen screw (8)
- slide back cover

To remove bottom cover:

- remove bottom feet (9)
- remove lower rear feet (3) (7)
- loosen screw (10)
- slide cover off

Chapter 17. Replacement Procedures

INTRODUCTION

This section contains procedures for removing the following assemblies:

- A1/A2 front panel and rotary pulse generator
- A18 display
- A16 rear panel and A15 preregulator
- A64/A65/A66 samplers
- J1/J2 test port connectors, A62/A63 directional couplers, and A56 lower front panel
- A60/A61 bias tees, A69 step attenuator and S4 transfer switch
- A51 test set interface
- A53 lowband assembly
- A58 M/D/S (M/A/D/S for HP 8722C)
- A55 YIG 1, and A54 YIG 2
- S1/S2/S3 microwave switches
- A59 source interface board
- A52 pulse generator

ADJUSTMENTS AND PERFORMANCE TESTS

When an assembly is replaced adjustment(s) and/or performance tests may be necessary to assure the analyzer meets its published specifications. Refer to the *Post–Repair Procedures* section of this manual for the specific adjustments and performance tests to be performed.

COVER REMOVAL

Many of the disassembly procedures in this section require the top portion of the instrument to be pivoted open or the covers to be removed. Details on how to remove the instrument covers and hardware to pivot open the analyzer are located on the tab labeled *Replacement Procedures*.

CAUTION

This product contains static–sensitive components. When handling these components or assemblies, work on an anti–static surface and use a static grounding bracelet.

WARNING

The AC line voltage inside the instrument can, if contacted, produce fatal electrical shock. DISCONNECT BOTH AC POWER CORDS FOR ALL DISASSEMBLY PROCEDURES! With the AC power cables connected to the instrument, the AC line voltage is present on the terminals of the line power modules on the rear panels, and the LINE power switch, whether the switch is ON or OFF. Be aware that capacitors inside the instrument may remain charged even though the instrument has been disconnected from its AC power source.

Table 17–1. Disassembly Tools

Tool	HP Part Number
Large Pozidrive	8710–0900
Small Pozidrive	8710–0899
Torx driver T–10 Torx driver T–15	8710–1623 8710–1622
Small flat blade screwdriver	8730–0008
Needlenose pliers	8710–0595
5/16" torque wrench 8 in–lb	8710–1765
1/2" torque wrench 50 in–lb	8710–1948

NOTE: Tighten all semi–rigid coax to 8 in–lb with an HP 8710–1765 torque wrench.

A1/A2 FRONT PANEL AND ROTARY PULSE GENERATOR REPLACEMENT

TOOLS REQUIRED

Small and large Pozidriv screwdrivers
Very small flat edge screwdriver
7/16" open–end wrench
Torx drivers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–1.

To Disassemble

1. Remove the handles and side covers. Pivot open the instrument, and remove the three screws from the bottom edge of the frame. (Refer to the tab at the front of this section for details).

2. Remove the bezel's softkey cover (item 1) by sliding your fingernail under the left edge, near the top or bottom of the cover. Pry the softkey cover away from the bezel. If you use another tool, take care not to scratch the glass.

3. Remove the two screws and washers (item 2) exposed by the previous step. The bezel (item 3) is now free from the frame. Remove it.

4. Remove the trim strip from the top edge of the front frame by prying under the strip with a flat screwdriver.

5. Remove two screws from the top edge of the frame (item 4).

6. Disconnect the ribbon cable from the front panel by pressing down and out on the connector locks. The front panel is now free of the instrument.

To Remove the Rotary Pulse Generator (RPG)

7. Disconnect the RPG cable from A2J5.

8. Pull the knob off the RPG shaft.

9. Remove the nut and washer from the RPG shaft.

To Reassemble

10. Reverse steps 1 through 9 to reassemble the front panel.

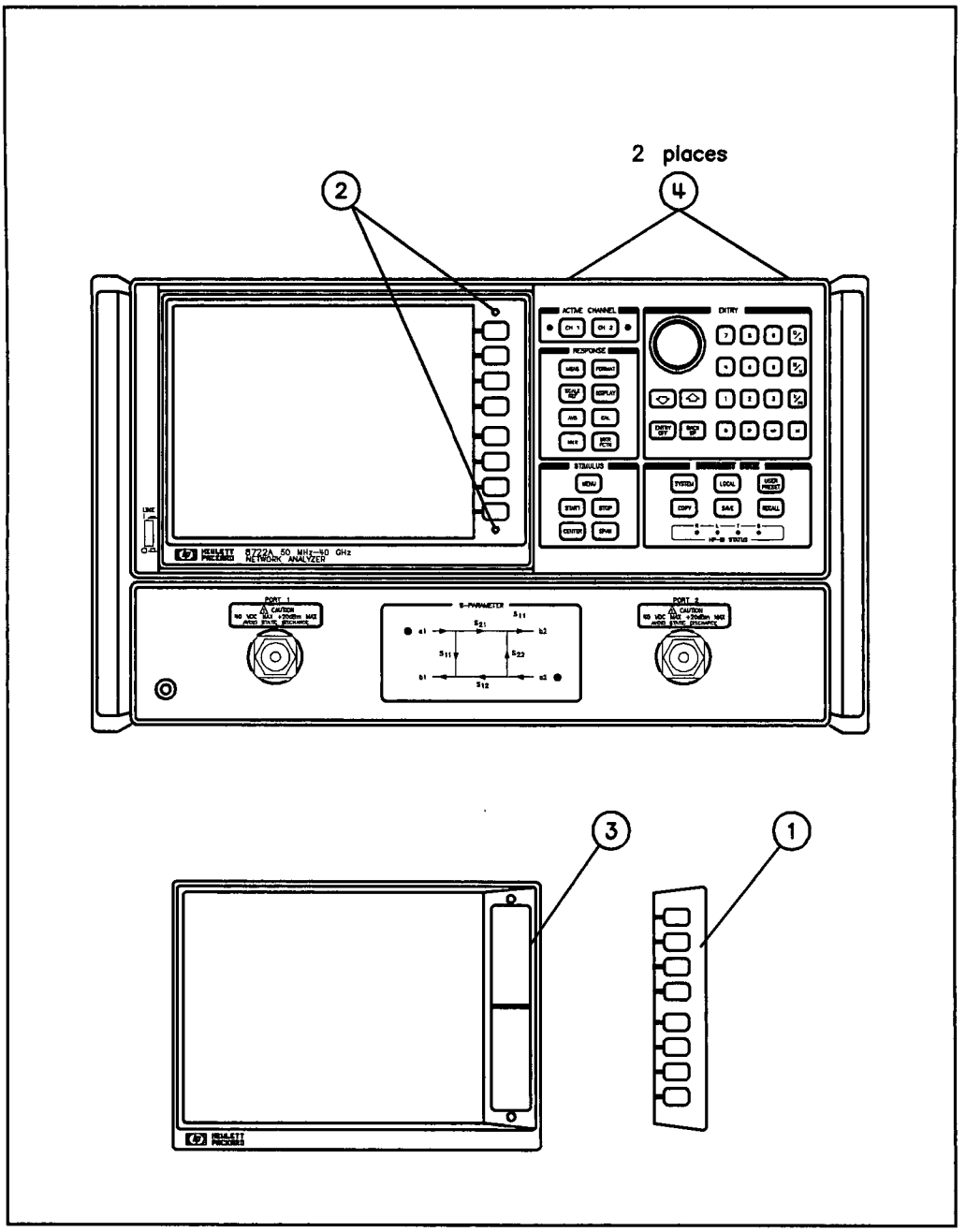


Figure 17–1

A18 DISPLAY REPLACEMENT

TOOLS REQUIRED

Small and large Pozidriv screwdriver
Small flat edge screwdriver
Torx drivers

PROCEDURE

To Disassemble

The items shown in parentheses refer to the corresponding item numbers in Figure 17–1.

1. Remove the handles, power cord, and the top and side covers (refer to the tab at the front of this section for details).

2. Remove the bezel's softkey cover (item 1) by sliding your fingernail under the left edge, near the top or bottom of the cover. Pry the softkey cover away from the bezel. If you use another tool, take care not to scratch the glass.

3. Remove the two screws and washers (item 2) exposed by the previous step. The bezel (item 3) is now free from the frame. The bezel is heavy for its size. Carefully remove it.

(Refer to Figure 17–2 for the rest of this procedure.)

4. Remove the four screws (item 1) from the top of the display.

5. Disconnect the display power cable assembly (item 2) from A19.

NOTE: If step 6 is performed while the instrument is pivoted closed, it will spring open as soon as the display is free.

6. Gently slide the display forward and out of the aluminum card cage.

To Reassemble

7. To install a new display unit, reverse the preceding steps.

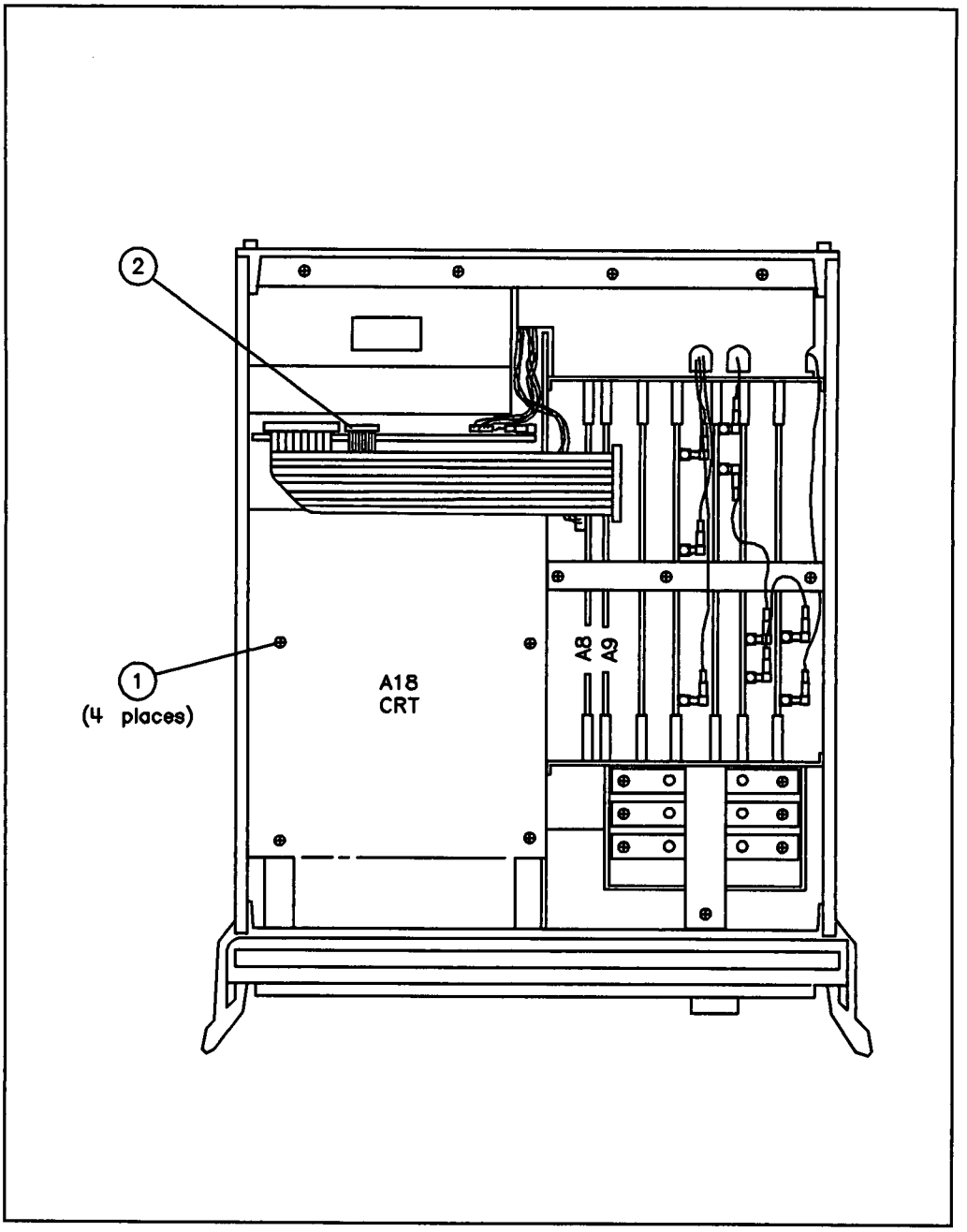


Figure 17–2

A16 REAR PANEL AND A15 PREREGULATOR REPLACEMENT

TOOLS REQUIRED

Large and small Pozidriv screwdrivers
Flat edge screwdriver
Pliers
9/32" open–end wrench
3/16" open–end wrench
9/16" open–end wrench
torx drivers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–3.

To Disassemble

1. Remove the handles, power cord, top and side covers and pivot open the instrument (refer to the tab at the front of this section for details).
2. Disengage the coax cables from the cable clip located on the motherboard.
3. Disconnect the ribbon cable from the interface board (item 1).
4. Disconnect the coax from the source interface board A59J23 (item 2).
5. Disconnect the A55 YIG 1 and A54 YIG 2 MC and FM coax cables (item 3).
6. Using pliers, remove the wire clamps from the two gas springs.
7. Lift the A12 reference assembly from its motherboard connector, and disconnect the EXT REF INPUT coax from A12J3.
8. Turn the instrument on its side.

NOTE: As the instrument is turned on its side, the gas springs will force the two halves of the instrument apart from each other.

9. Remove the gas springs by prying off each end with a flat edge screwdriver.

10. Remove seven screws from the back panel assembly; two from the bottom, three from the back, and two from the top (items 4 and 5).

11. Pull the rear panel assembly away from the frame. Disconnect the HP–IB ribbon cable and the fan cable assembly.

To Remove the A16 Rear Panel Assembly

12. Remove the hex screws (item 6) from the HP–IB connector and the I/O INTERCONNECT. Disconnect cables W21, W22, and W23 from their SMB connectors on the A19 assembly. Remove the hex nuts and lock washers from the BNC connectors labeled AUX INPUT, and EXT TRIGGER.

To Remove the Preregulator

13. Remove the remaining four screws in the rear frame; two on the top and two on the bottom (items 7 and 8).

14. Disconnect the preregulator cable from the A8 post–regulator board assembly.

15. Pull the preregulator assembly away from the frame. Disconnect the cable assembly at the J3 preregulator connection to the motherboard.

To Reassemble

16. To install a new preregulator, reverse the above procedure.

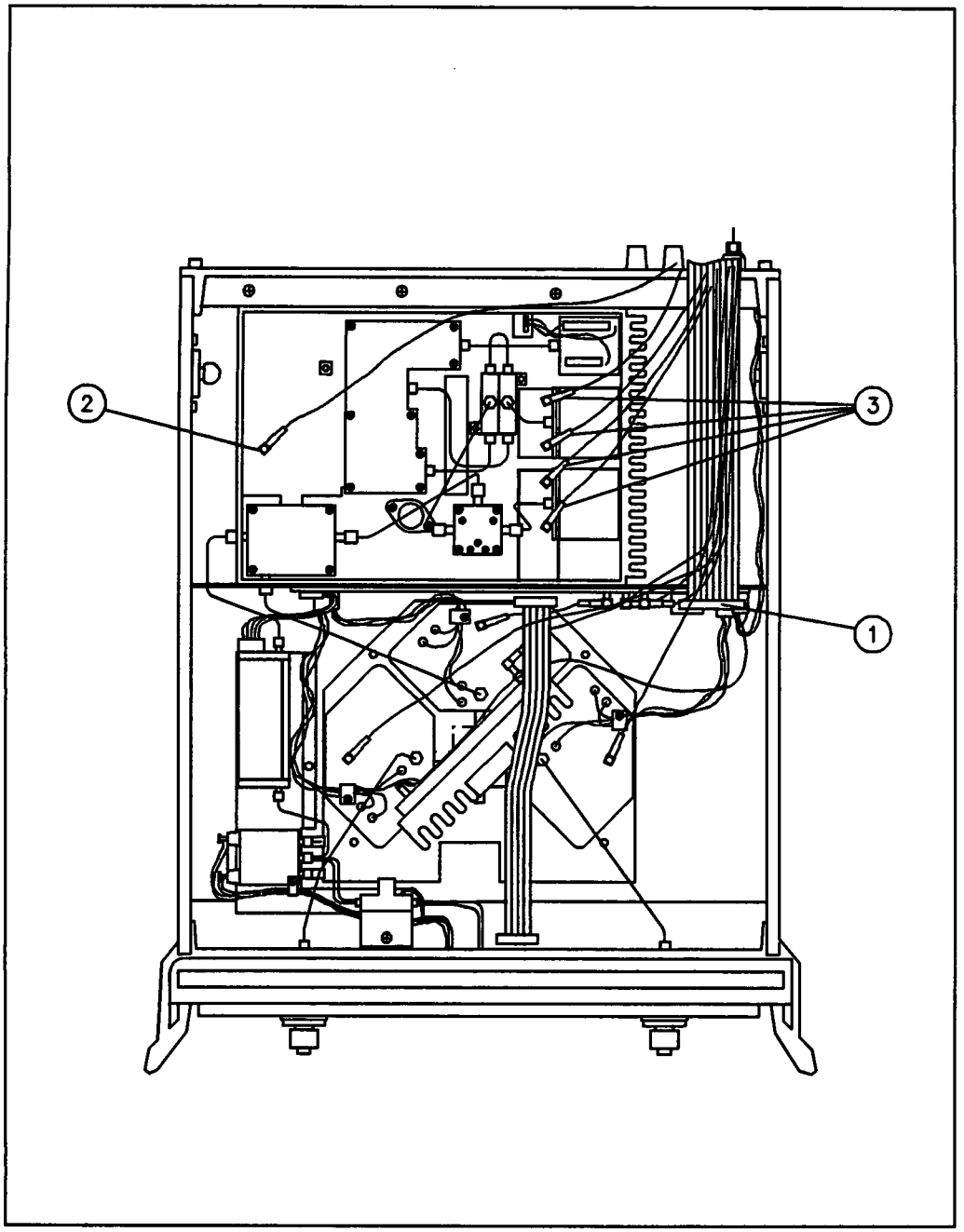


Figure 17–3 (1 of 2)

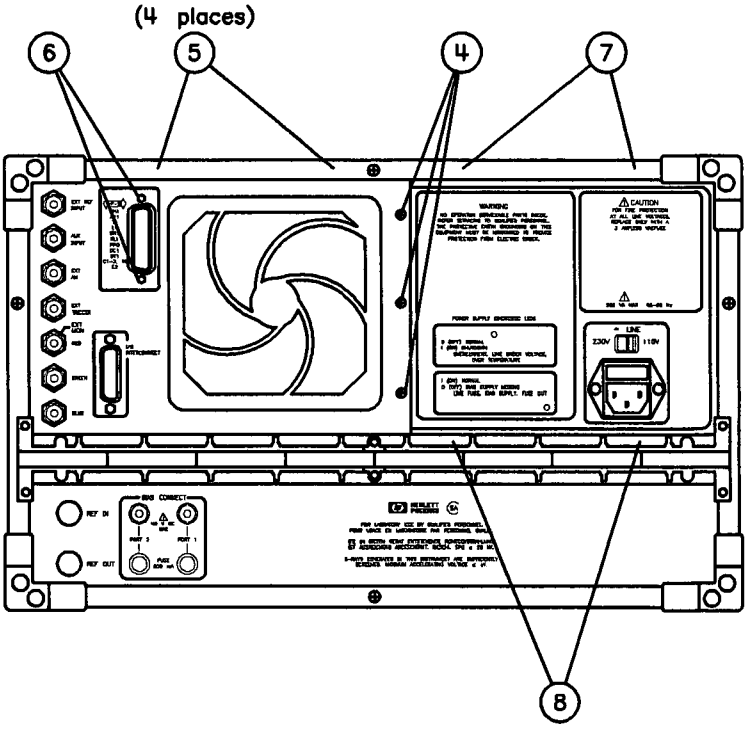


Figure 17–3 (2 of 2)

A64/A65/A66 SAMPLER REPLACEMENT

TOOLS REQUIRED

Large and small Pozidriv screwdrivers
5/16" open–end wrench
Torx drivers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–4.

To Disassemble

1. Remove the handles, top cover, both side covers, and pivot open the instrument (refer to the tab at the front of this section for details).

To Remove the A or B Sampler

2. Disconnect the J3 IF OUTPUT coax cable (item 1).
3. Remove the COUPLER/J2 RF INPUT semi–rigid cable (item 2).
4. Remove two screws (item 3).

NOTE: A slight upward force may need to be applied to the pulse generator assembly to free the A sampler while performing step 5.

5. Disconnect each sampler to be replaced from the pulse driver at the LO INPUT J1 connection (item 8).

To Remove the R Sampler

6. Disconnect the J2 RF INPUT connection (item 4).
7. Disconnect the J3 IF OUTPUT coax cable (item 5).
8. Disconnect the semi–rigid cables from J2 of both the A and B samplers (item 2), and the semi–rigid cable from J3 of the A58 M/D/S (item 7).
9. Remove the 4 screws that connect the sampler/pulse generator baseplate to the bottom of the instrument (item 6).
   a. Remove two screws from the top side of the sampler (item 3).
   b. Loosen the connection to J1 of the R sampler.
10. While gently lifting the sampler/pulse generator baseplate, disconnect the R sampler from the pulse driver at the LO input J1.

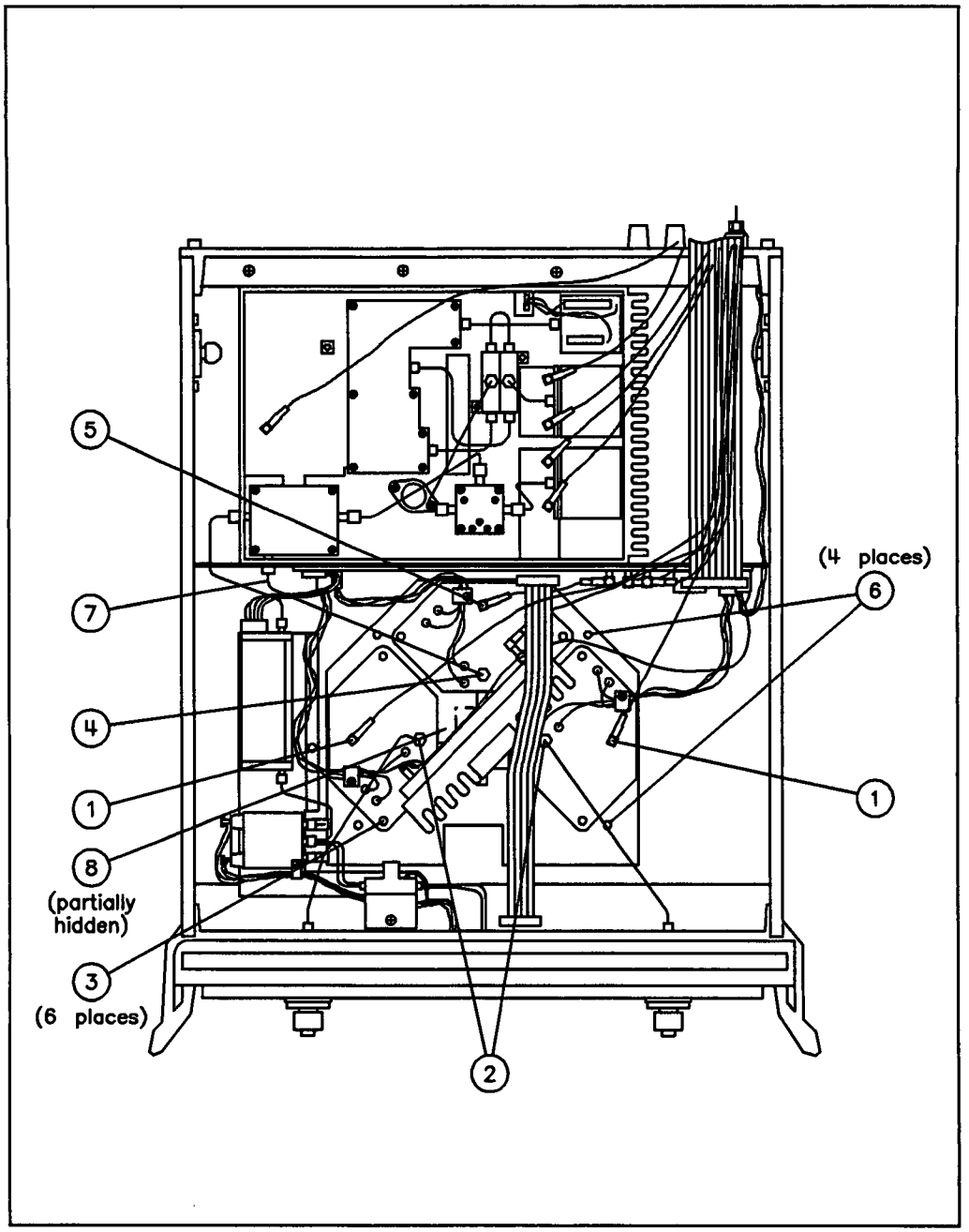


Figure 17–4

To Reassemble

11. Reverse the above procedure to reassemble the unit.

J1/J2 TEST PORT CONNECTORS, A62/A63 DIRECTIONAL COUPLERS, AND A56 LOWER FRONT PANEL REPLACEMENT

TOOLS REQUIRED

Large and small Pozidriv screwdrivers
5/16" open–end wrench
1" open–end wrench
1/2" thin open–end wrench

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–5.

To Remove the Test Port Connectors and Directional Couplers

1. If removing the test port connectors only, remove the test port connector at the gold fitting before the test port flange nut. Continue if removing the couplers or front panel.
2. Remove the test port flange nut and the washer underneath (item 1).
3. Remove the side and bottom covers, and pivot open the instrument (refer to the tab at the front of this section).
4. Remove the PORT 1 and PORT 2 coupler/bias tee cables (item 2).
5. Remove one sampler/coupler semi–rigid cable for each port (item 3).
6. Disconnect the cable assembly on the front panel board (item 7).
7. Remove the ribbon cable connecting the front panel board to the A51 at the A51. (item 4).
8. Remove four screws on the top and four screws on the bottom of the front frame (item 8).
9. Pull the front panel assembly free from the frame.

To Remove the Front Panel Board

10. Remove the remaining three screws from the front panel board.

To Reassemble

11. Reverse the above procedure to reassemble the unit.

NOTE: When replacing a test port connector, refer to the *Connector Care* section in the *Operating Manual* for connector gage information. Tighten the test port connector to 50 in−lbs using the HP 8710−1948 torque wrench.

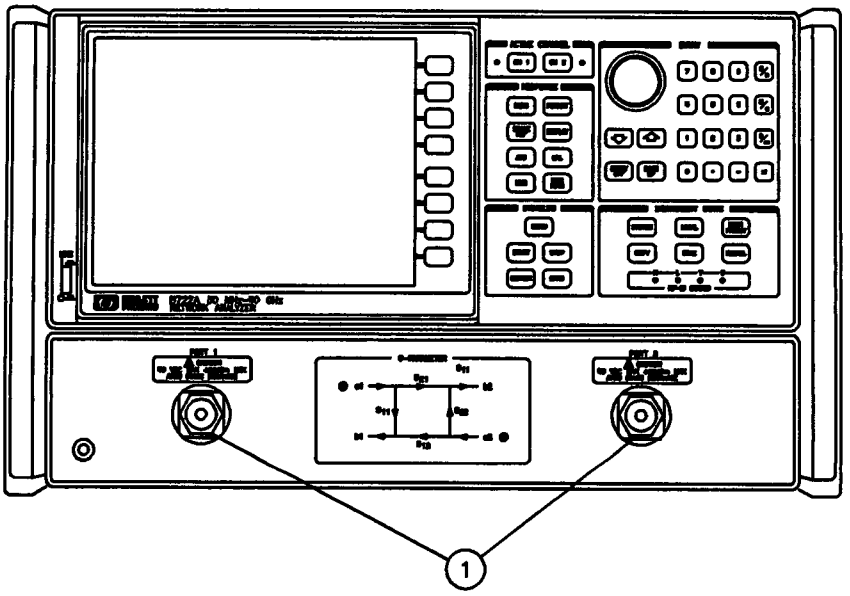


Figure 17−5 (1 of 2)

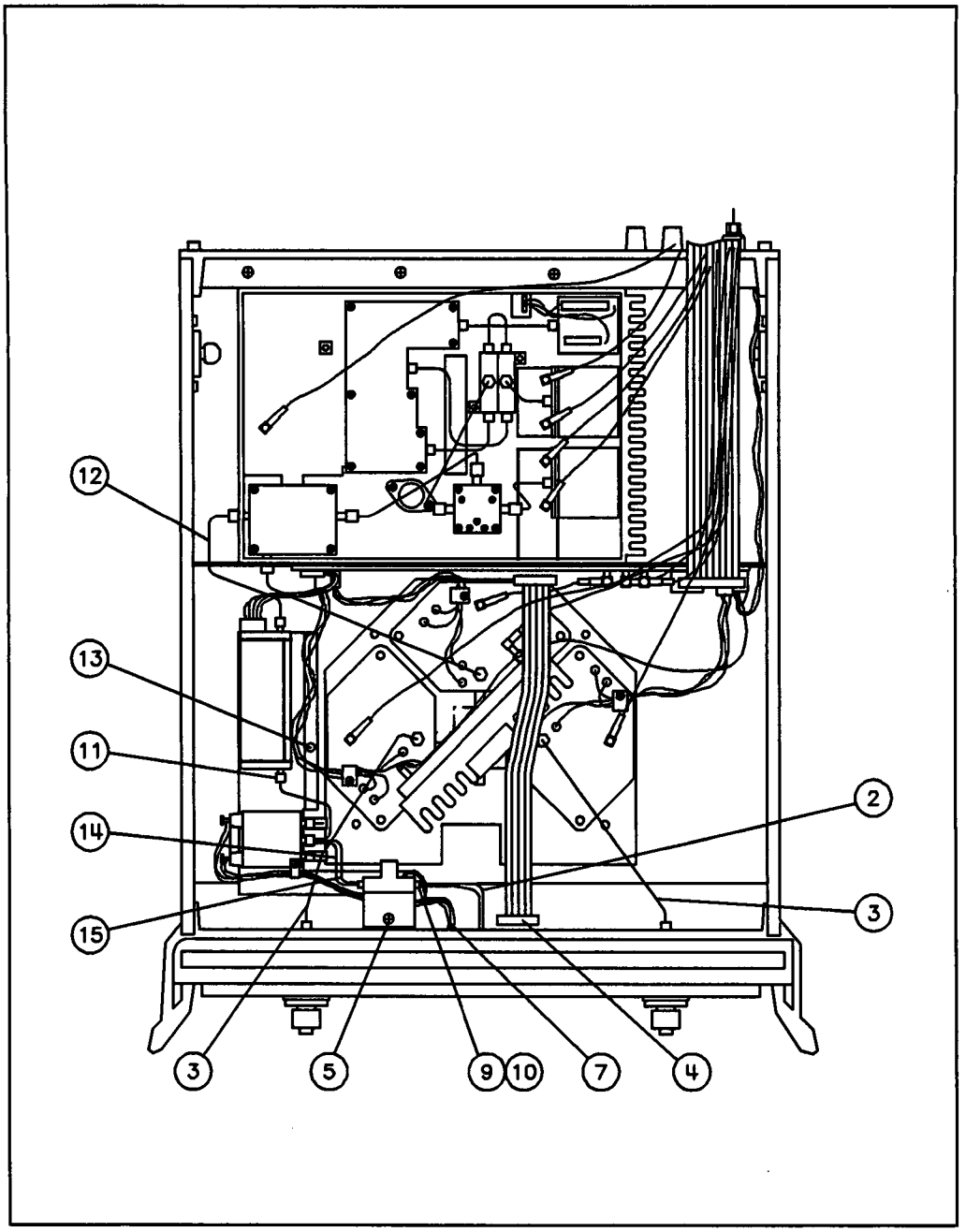


Figure 17–5 (2 of 2)

A60/A61 BIAS TEES, A69 STEP ATTENUATOR, AND S4 TRANSFER SWITCH REPLACEMENT

TOOLS REQUIRED

5/16" open–end wrench
Large and small Pozidriv screwdrivers
Torx drivers

PROCEDURE

The items shown in parenthesis refer to Figure 17–5.

To Remove the Bias Tees

1. Remove the handles, side covers, and pivot open the instrument (refer to the tab at the front of this section).

2. Disconnect the two bias tee/coupler cables at the bias tee connection (items 9 and 10). Remove the cable between A65J2 and the A62 Port 1 coupler (item 3).

3. Disconnect the cable assembly from the lower front panel board (item 7). Disconnect the cable between the A58 M/D/S and the A69 step attenuator at the A59 (item 12).

4. Remove the screws on the mounting bracket (items 5, 13).

5. Remove the bracket containing the step attenuator, S4, and bias tees.

NOTE: One cable and two screws must be removed for each bias tee that is to be removed.

To Remove the Transfer Switch

6. Remove the remaining semi–rigid cables. (items 11, 14, 15).

7. Remove the two screws that hold the transfer switch to the mounting bracket.

NOTE: The transfer switch assembly consists of 3 individual pin switches, 2 40GHz loads, and interconnecting cables. This assembly can be replaced as a unit for ease of troubleshooting.

To Remove the Step Attenuator

8. Disconnect the ribbon cable assembly from the A51J2.

9. Disconnect the cable between the step attenuator and S4 at the step attenuator (item 11).

10. Remove the two screws holding the step attenuator from the bottom of the bracket.

To Reassemble

11. Reverse the above procedure to reassemble the unit.

A51 TEST SET INTERFACE REPLACEMENT

TOOLS REQUIRED

Torx screwdrivers
Large and small Pozidrive screwdrivers

PROCEDURE

To Disassemble

1. Remove the side and bottom covers, and pivot open the instrument (refer to the tab at the front of this section).

2. Disconnect all cables, coax connectors, and ribbon cable assemblies from the test set interface board.

3. Gently pull the white knob on the A51 toward the front of the instrument and at the same time, lift the A51 straight up and out of the instrument.

To Reassamble

4. Make sure the two guide pins protrude through the holes in the A51 board. While pulling slightly toward the front of the instrument, slide the A51 downward into its socket.

A53 LOW BAND REPLACEMENT

TOOLS REQUIRED

Torx screwdrivers
Large and small Pozidrive screwdrivers
Pliers
5/16" open–end wrench

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–6.

To Disassemble

1. Remove handles, sides, and bottom cover.
2. Turn the instrument on its right side.

NOTE: As the instrument is turned on its side, the gas springs will force the two halves of the instrument apart from each other.

3. Using pliers, remove the wire clamps from one end of the two gas springs.
4. Disconnect one end of the gas spring to allow the halves to be pivoted further open.
5. Remove the three coax cables from the cable clips on the motherboard.
6. Disconnect YIG1 and YIG2 SMB connectors from the YIGs.
7. Pivot the instrument open enough to allow free access to the lower box assemblies.

   Remove top source housing cover by removing 3 screws and sliding cover towards front of the instrument.

   Remove bottom source housing by removing 3 screws and sliding cover toward front of instrument.

8. Completely remove the semi–rigid coax between the A57 fixed oscillator and the lowband assembly (item 4).
9. Disconnect the other two semi–rigid coax cables from the A53 (item 5).
10. Disconnect the coax from A59J23 (item 6).

11. Remove the 4 screws from the corners of the A53 (item 7).

12. Pull the A53 straight out from the A59 source interface board.

To Reassemble

13. Installation is the reverse of the above. Use the guides cast into the source housing to help guide the A53 into place. After inserting the A53 assembly, look at the sockets from the bottom of the A59 source board to make sure the A53 pins engaged the sockets correctly.

A58 M/D/S MICROCIRCUIT–HP 8722A
A58 M/A/D/S MICROCIRCUIT–HP 8722C

TOOLS REQUIRED

Large and small Pozidrive screwdrivers
Torx screwdriver
Pliers
5/16" open–end wrench

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–6.

To Disassemble

1. Remove handles, sides, and bottom cover.
2. Turn the instrument on its right side.

NOTE: As the instrument is turned on its side, the gas springs will force the two halves of the instrument apart from each other.

3. Using pliers, remove the wire clamps from one end of the two gas springs.
4. Disconnect one end of the gas spring to allow the halves to be pivoted further open.
5. Remove the three coax cables from the cable clips on the motherboard.
6. Disconnect YIG1 and YIG2 SMB connectors from the YIGs.
7. Pivot the instrument open enough to allow free access to the lower box assemblies.

   Remove top source housing cover by removing 3 screws and sliding cover towards front of the instrument.

   Remove bottom source housing by removing 3 screws and sliding cover toward front of instrument.
8. Completely remove the semi–rigid coax cable that connects the A69 step attenuator to the M/D/S (M/A/D/S) and set aside (item 1).
9. Disconnect the other 2 semi–rigid coax cables from the M/D/S (M/A/D/S) (item 2).
10. Remove the 4 screws securing the M/D/S (M/A/D/S) (item 3).
11. Remove the M/D/S (M/A/D/S) by pulling it straight out away from the source interface board.

To Reassemble

12. Make all pins on the M/D/S (M/A/D/S) straight and perpendicular to the package.

13. Using the lower package guide and sighting through the hole in side of the source housing, engage the pins of the M/D/S (M/A/D/S) with the sockets in the source interface board and press into place.

14. Verify that all pins engaged properly by looking through the open bottom sockets in the source board.

15. The remainder of reassembly is the reverse of the disassembly procedure.

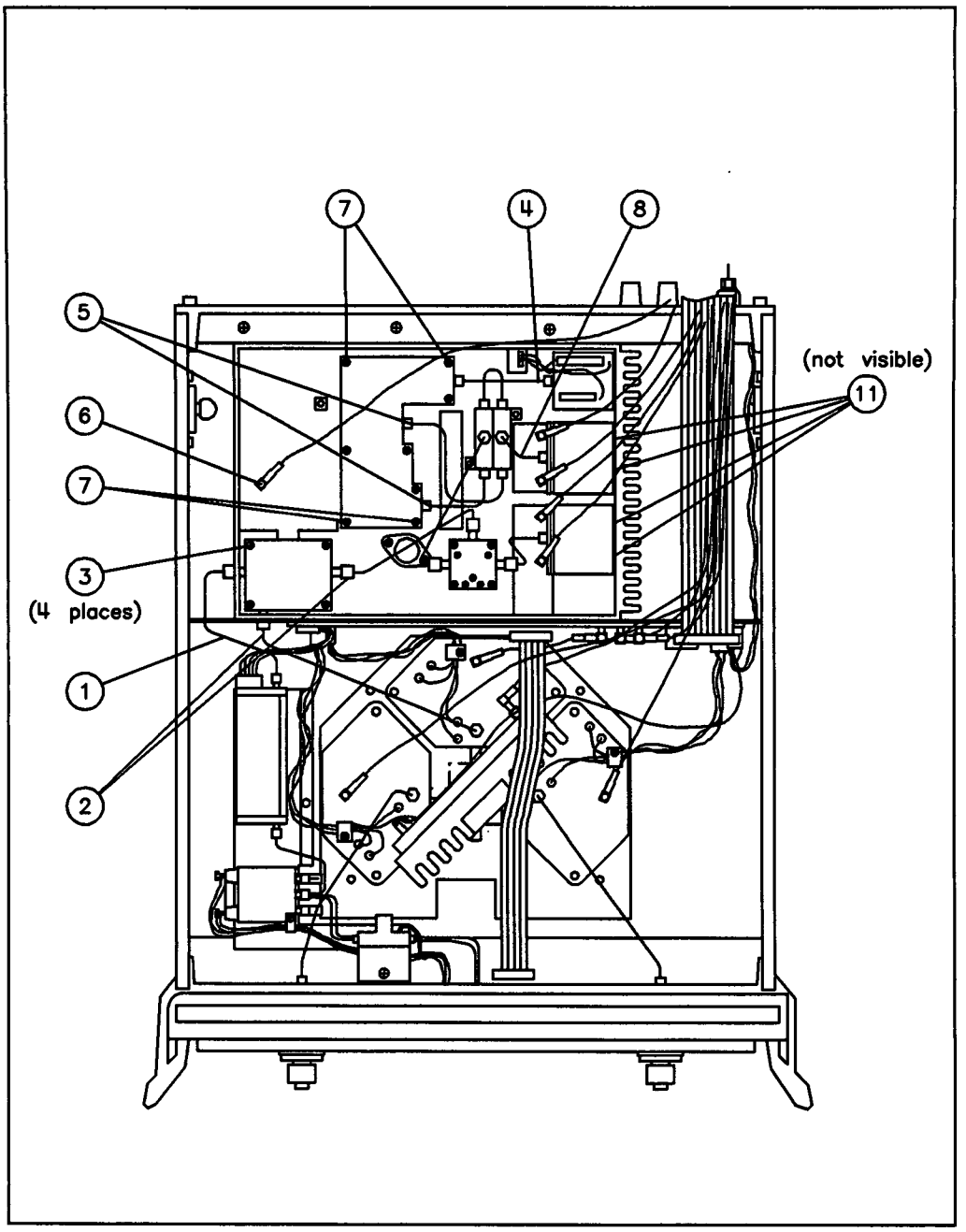


Figure 17–6

A55 YIG 1 AND A54 YIG2 REPLACEMENT

TOOLS REQUIRED

Large and small Pozidriv screwdrivers
5/16" open–end wrench
Torx screwdrivers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–6.

To Disassemble

1. Remove the handles and side covers and pivot open the instrument (refer to the tab at the front of this section).

   Remove top source housing cover by disconnecting YIG 1 and YIG2 FM and MC coax cables, removing 3 screws and sliding cover towards front of the instrument.

2. Remove the semi–rigid cable connecting YIG 1 and S3 (item 8), or YIG2 and S1.

3. Remove 4 screws from the heat sink (item 11).

4. Gently rock the oscillator assembly and lift straight up to pull it free from the main deck.

To Reassemble

5. Reverse the above procedure to reassemble the instrument.

S1/S2/S3 MICROWAVE SWITCH REPLACEMENT

TOOLS REQUIRED

Large and small Pozidrive screwdrivers
Torx screwdrivers
5/16" open–end wrench

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–7.

To Disassemble

1. Remove the handles and side covers and pivot open the instrument (refer to the tab at the front of this section).

   Remove top source housing cover by disconnecting YIG 1 FM and MC coax cables, removing 3 screws and sliding cover towards front of the instrument.

2. **S2/S3**
   Disconnect the following semi–rigid cables from the switch connection

   lowband microcircuit/SW2 (item 1)
   lowband microcircuit/SW3 (item 2)
   M/D/S / SW2 (item 3)
   YIG 1 / SW3 (item 4)

3. Remove the two screws that attach the mounting bracket to the main deck (item 5). Lift the switch assembly straight up to disconnect the pins. Then remove the switch assembly from the instrument.

4. Remove one screw on each side of the switch package to detach the mounting bracket.

5. **S1**
   Disconnect the following semi–rigid cables from S1

   S2/S1 (item 6)
   M/D/S/S1 (item 7)
   A54/S1 (item 8)

6. Remove the 4 screws from S1 and lift the switch straight up and out.

To Reassemble

7. Reverse the above procedure to reassemble the unit.

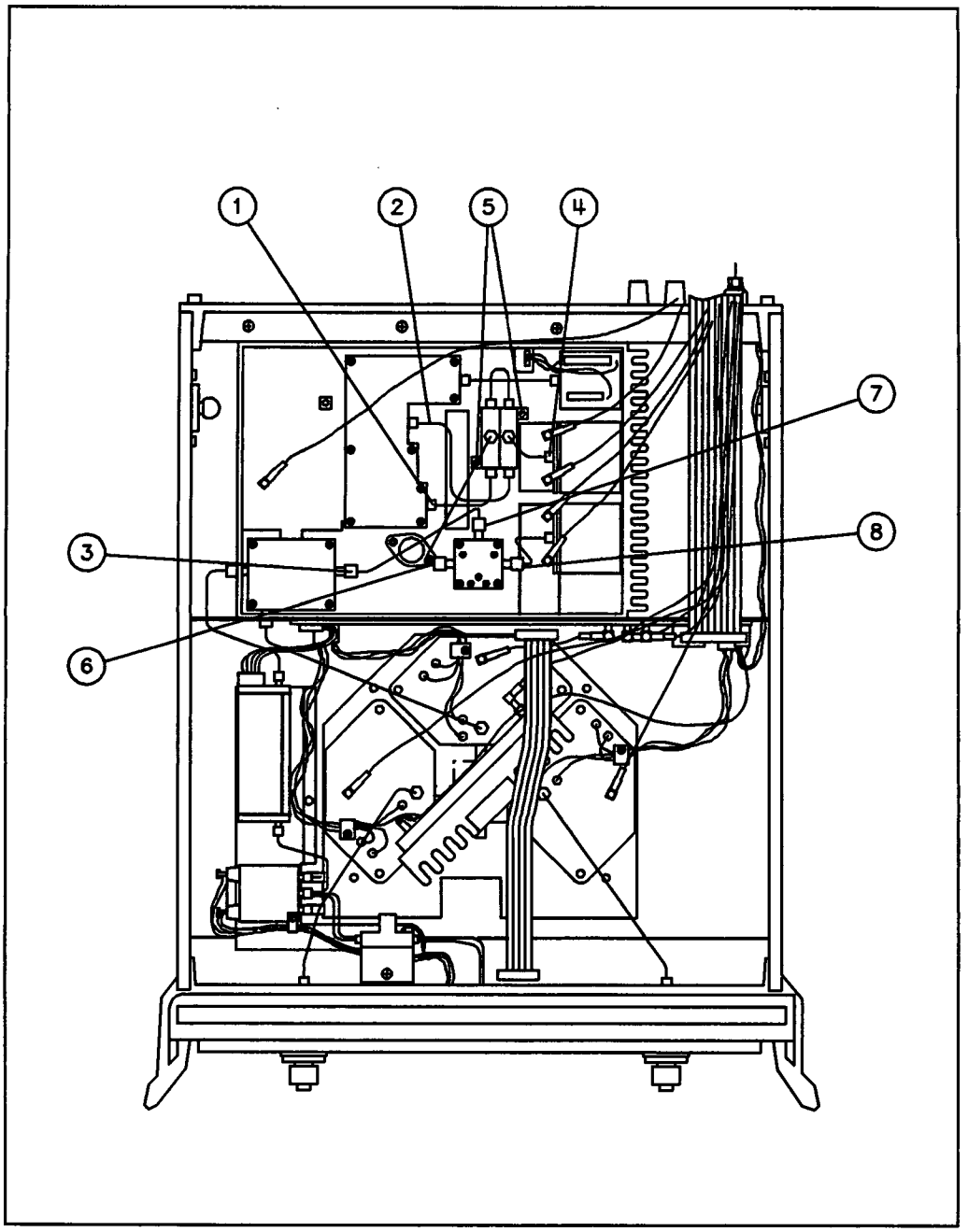


Figure 17–7

A59 SOURCE INTERFACE REPLACEMENT

TOOLS REQUIRED

Torx screwdrivers
Large and small Pozidrive screwdrivers

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–8.

To Disassemble

1. Remove handles, side, and bottom covers and pivot open the instrument (refer to the tab at the front of the section for details).

   Remove top source housing cover by disconnecting YIG 1 and YIG2 FM and MC coax cables, removing 3 screws and sliding cover towards front of the instrument.

   Remove bottom source housing by removing 3 screws and sliding cover toward front of instrument.

2. Remove the coax cable from A59J23 (item 1).

3. Remove the fixed oscillator cable from A59J3 (item 2).

4. Turn the instrument on its side.

NOTE: As the instrument is turned on its side, the gas springs will force the two halves of the instrument apart from each other.

   a. Remove the 4 screws from the bottom of the A59 board (item 3).

5. At the same time, push from the inside and pull from the outside to remove A59. Carefully keeping the board coplanar with the bottom of the instrument to avoid bending pins of the source module components.

To Reassemble

6. Line up pins from the source module components with the sockets in A59 and gently work the A59 into place. Special open bottomed sockets are used in the A59 to make it possible to see that all of the pins are properly engaged. It is helpful to line up the pins from the M/D/S first, then rock the A59 into place using the connector from the A51 as a guide.

7. Secure A59 with 4 screws and replace covers.

8. Reconnect cables at A59J23 and A59J3.

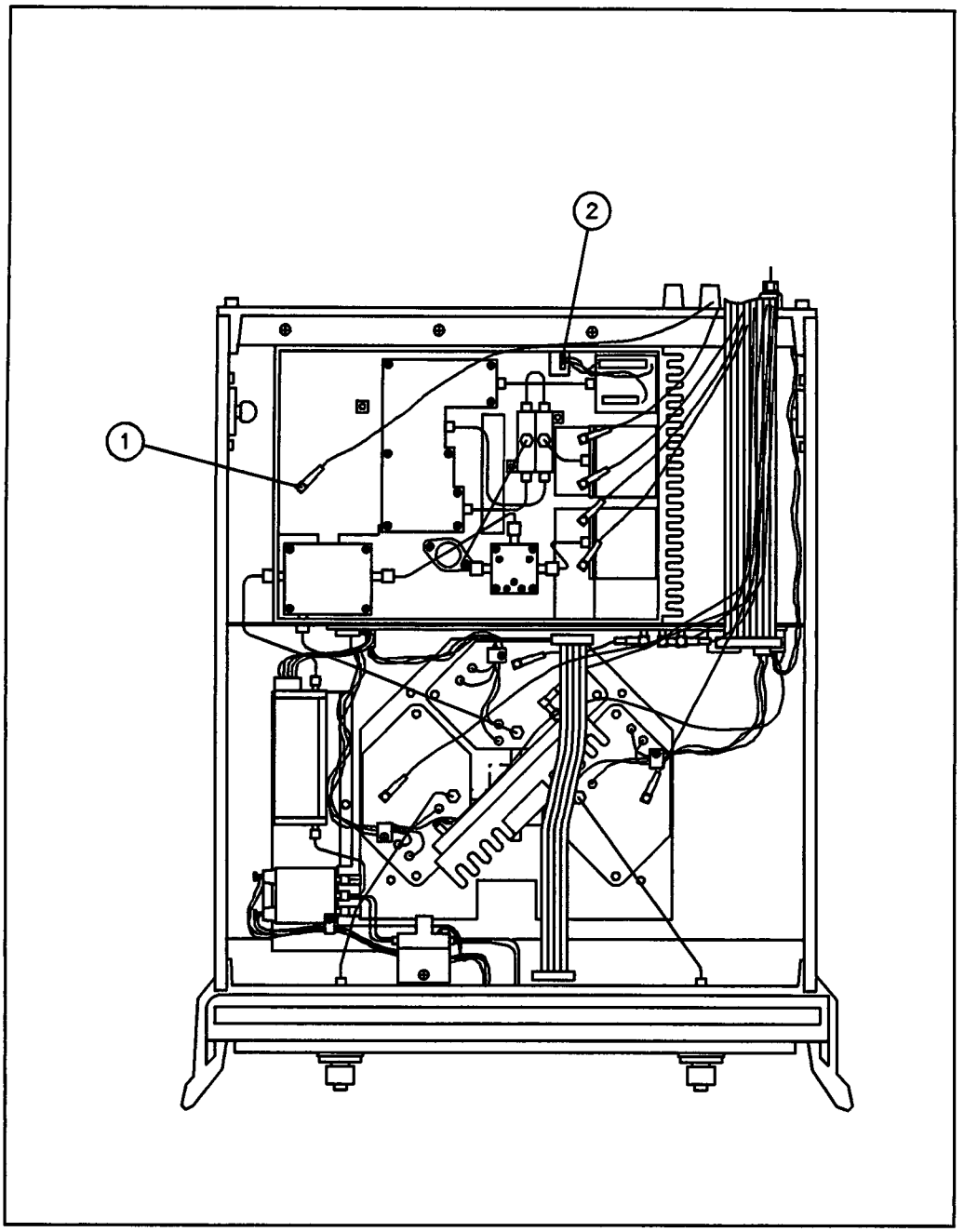


Figure 17–8 (1 of 2)

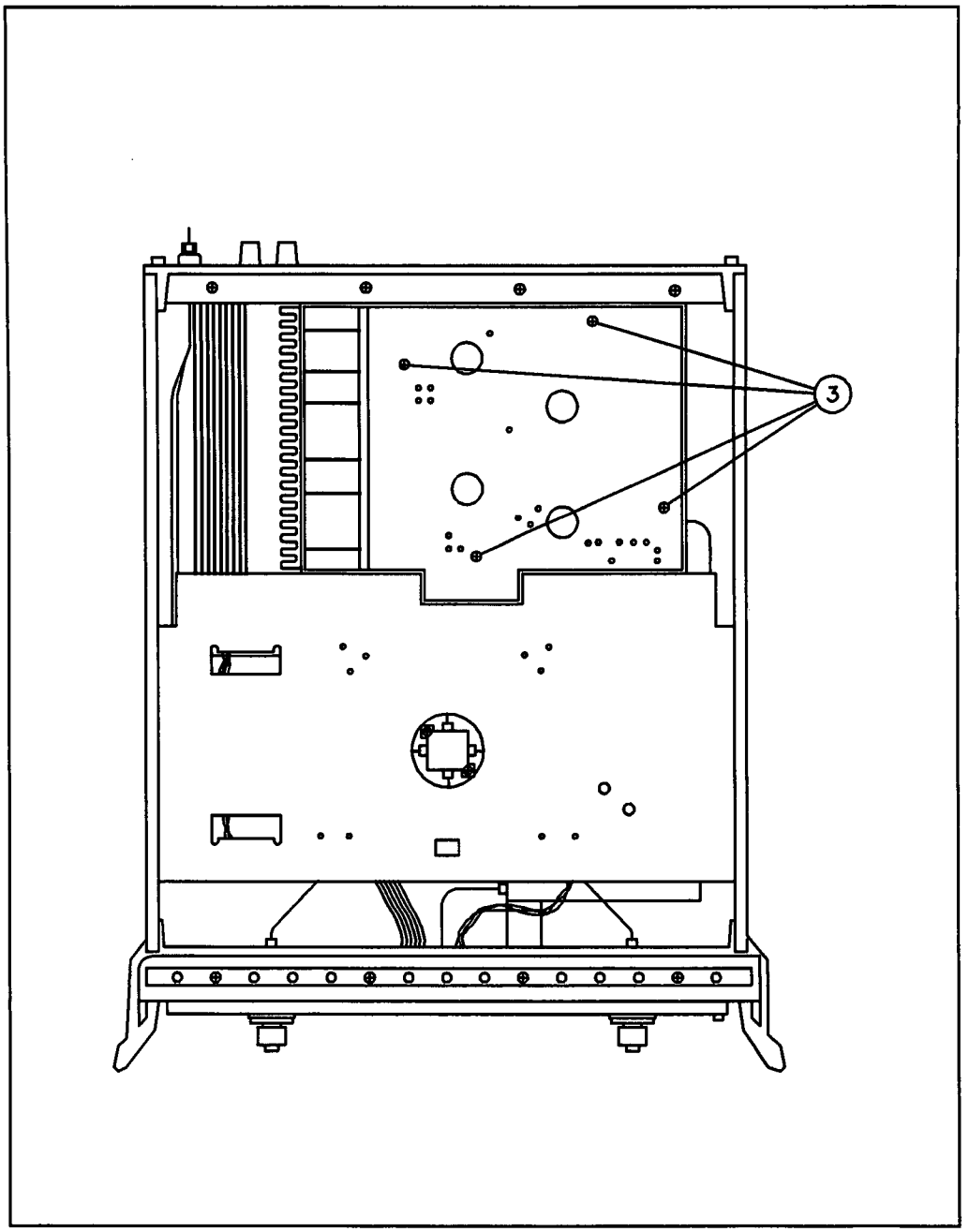


Figure 17–8 (2 of 2)

A52 PULSE GENERATOR REPLACEMENT

TOOLS REQUIRED

Torx screwdrivers
5/16" open end wrench
Large and small pozidrive screwdriver

PROCEDURE

The items shown in parentheses refer to the corresponding item numbers in Figure 17–9.

To Disassemble

1. Remove the handles, both side covers, and the bottom cover. Pivot open the instrument. (Refer to the tab at the front of this section for details.)

2. Lay the instrument on its left side.

3. Disconnect the semi–rigid cable from J2 RF input of both the A and B sampler (item 1).

4. Disconnect the two cables connected to the pulse generator assembly (item 2).

5. Remove the two screws securing the pulse generator assembly to the A and R samplers (item 3).

6. Remove the remaining 3 screws holding the A and B samplers in place (item 4).

7. From the bottom of the test set, disconnect the A and B samplers from the pulse generator assembly (item 5).

8. From the bottom of the test set, disconnect the pulse generator assembly from the R sampler (item 6) and remove pulse generator assembly.

To Reassemble

9. Reverse the above procedure to reassemble the unit.

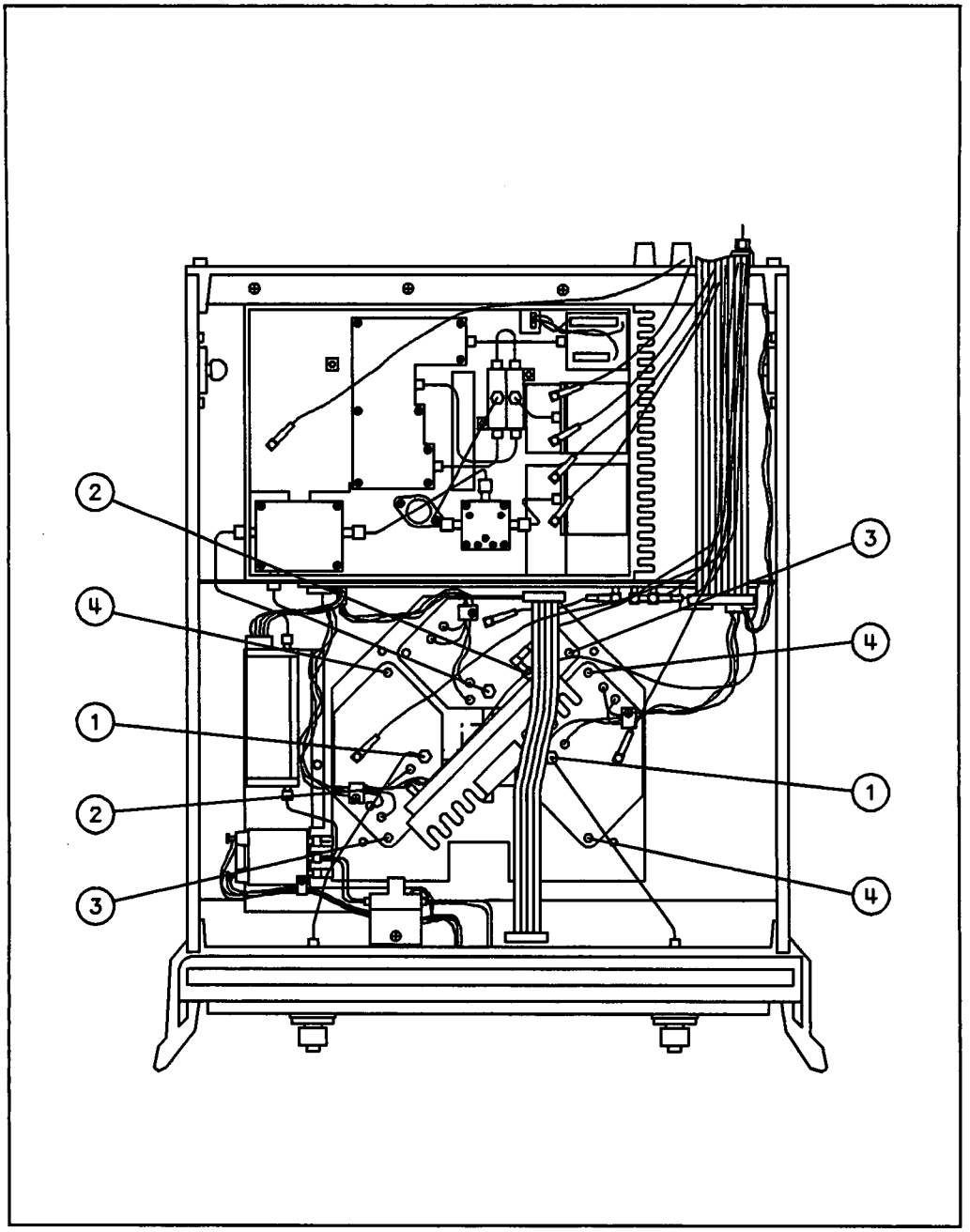


Figure 17–9 (1 of 2)

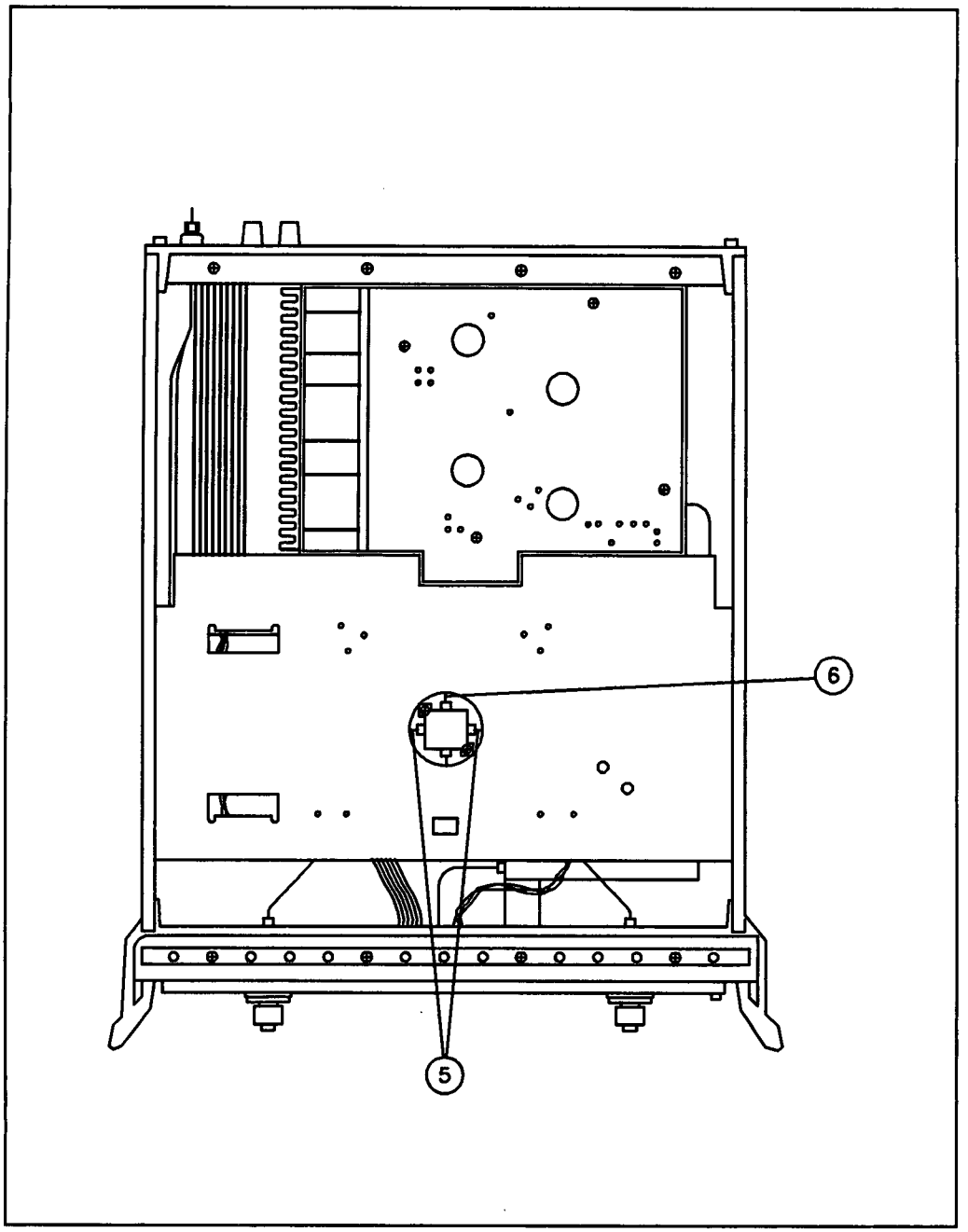


Figure 17–9 (2 of 2)

POST-REPAIR PROCEDURES

Chapter 18. Post–Repair Procedures

INTRODUCTION

Repairing the analyzer or replacing an assembly is seldom the final step in the repair process. The assemblies of the instrument are both complex and interactive. An adjustment or instrument check or both is usually required following a repair. Table 18–1, *Related Service Procedures*, addresses the question of what to adjust and verify following a repair.

The first column of Table 18–1 lists every replaceable assembly in the instrument. The second column notes adjustments that should be performed following replacement of an assembly. The third column references the internal test or other method used to verify the proper functioning of the instrument following repair.

Generating a new set of error term plots is always a good idea following a major repair. Include the new plots in the system log for future reference. See *Error Terms* for more information.

Table 18–1. Related Service Procedures (1 of 2)

Replaced Assembly	Adjustments/ Correction Constants	Verification
A1 Front Panel	None	Internal tests #12, 23, and 24
A2 Front Panel Processor	Display Intensity	Internal test #12
A4/A5/A6 Second Converter	None	System Verification
A8 Post–Regulator	None	Self–Test Check A8 test point voltages
A9 CPU	Display Intensity CC Serial Number CC Option Number CC Analog Bus CC ADC Linearity CC Source Pretune CC IF Amplifier CC Cal Kit Defaults CC	System Verification
A10 Digital IF	Analog Bus CC ADC Linearity CC IF Amplifier CC	Internal tests #17, 18, and 19 System Verification Dynamic Range
A11 Phase Lock	Analog Bus CC Source Pretune CC	Frequency Accuracy
A12 Reference	Reference Asssembly VCO Tune Adjustmen Frequency Accuracy Adjustment	Frequency Accuracy

Table 18–1. Related Service Procedures (1 of 2)

Replaced Assembly	Adjustments/ Correction Constants	Verification
A13 Fractional–N (Analog)	ABUS	Frequency Accuracy Internal test #20
A14 Fractional–N (Digital)	ABUS	Frequency Accuracy Internal test #20
A15 Preregulator	None	Check A15 LEDs
A16 Rear Panel	None	Internal test #13: Rear Panel
A17 Motherboard	None	Self–Test Operator's Check
A18 Display	Display Position and Focus Intensity Adj Degauss	Observation
A19 GSP	Display Intensity Adjustments	Observation
A51 Test Set Interface	None	Operator's Check
A52 Pulse Generator	Power Adjustments	System Verification
A53 Low Band Asssembly	Power Adjustments	Power Level Frequency Accuracy
A54 YIG2 20 – 40 GHz	Source Pretune CC	Power Level Frequency Accuracy
A55 YIG1 2.55 – 20 GHz	Source Pretune CC Low Band Adj.	Power Level Frequency Accuracy
A56 Lower Front Panel Assembly	None	Observation (watch LEDs when switching from S11 to S22)
A57Fixed Oscillator	Power Adjustments	Power Level Frequency Accuracy
A58 M/D/S	Power Adjustments	Power Level
A59 Source Interface	Power Adjustments	Power Level
A60/61 DC Bias Tees	Continuity	System Verification
A62/A63 Directional Couplers	None	System Verification
A64 R Sampler	Sampler Check Power Adjustment	System Verification AND Power Level
A65 A Sampler	Sampler Check	System Verification
A66 B Sampler	Sampler Check	System Verification
A68 6 dB Attenuator	Op Check Port 1 & 2	Operator's Check
A69 Step Attenuator	None	Operator's Check
S1/S2/S3 Switches	None	Operator's Check
S4 Transfer Switch	None	Operator's Check

INSTRUMENT HISTORY

Chapter 19. Instrument History

INTRODUCTION

This section of the manual usually contains information required to adapt the manual so that it applies to earlier versions or configurations of the instrument. Because there are no earlier versions of the HP 8722A, there is no information: the information in this manual applies directly to all HP 8722A network analyzers that have the serial number prefix listed on the title page.

Instruments manufactured after the printing of this manual may be different from those documented here. Later instrument versions will be documented in the manuals shipped with those instruments. For further information on manual changes, refer to *Instruments Covered by Manual* in the *System Overview* section of the *Operating and Programming Manual.*

INDEX

HP 8722A/C NETWORK ANALYZER

OPERATING AND SERVICE INDEX

Numbers

2–Port Calibration, Full, 2–2

25 Ohm Mismatch Airline, 4–20

2nd Converter, 11–5

50 Ohm Airline, 4–20

85050B Calibration Kit
  Measurement Port Specifications, 3–62
  Measurement Uncertainty, Transmission Measurements, 3–54

85050D Calibration Kit
  Measurement Port Specifications, 3–53
  Measurement Uncertainty, Transmission Measurements, 3–45

85052B Calibration Kit
  Measurement Port Specifications, 3–44
  Measurement Uncertainty, Transmission Measurements, 3–36

85052D Calibration Kit
  Measurement Port Specifications, 3–35
  Measurement Uncertainty, Transmission Measurements, 3–27

85054B Calibration Kit
  Measurement Port Specifications, 3–80
  Measurement Uncertainty, Transmission Measurements, 3–72

85054D Calibration Kit
  Measurement Port Specifications, 3–71
  Measurement Uncertainty, Transmission Measurements, 3–63

85056A Calibration Kit
  Measurement Port Specifications, 3–17, 3–26
  Measurement Uncertainty, Transmission Measurements, 3–9, 3–18

85056K Calibration Kit
  Measurement Port Characteristics, 3–89
  Measurement Uncertainty, Transmission Measurements, 3–81

A

A and B Samplers, 11–4

A or B Signal Path, Faulty, 11–5

A1/A2 Front Panel, Troubleshooting, 9–9

A12 Reference, 10–5
  Crystal Reference Frequencies, 15–12

A14 Fractional–N, 10–5

A14 VCO Range Check with Oscilloscope, 10–6

A15 Preregulator, 15–3

A15 Preregulator and Loads, 8–3

A64 R Sampler, 10–4

A8 Display, Voltages, 8–9

A8 Post–Regulator and Loads, 8–6

A9 CC Jumper Position, 5–2
  Procedure, 5–3

A9 CPU Check, 9–2

Abbreviations, 16–3

Abus (Analog Bus) Test Failure, 9–1

ABUS Cor. *See* Adjustment Tests

ABUS Test. *See* Internal Tests

Accessories, Troubleshooting, 7–3, 12–1
  Inspect and Gauge Connectors, 12–1
  Inspect Error Terms, 12–3
  Switch Repeatability, 12–2

Accuracy Enhancement, 3–2, 14–1

ADC, Main, 13–16

ADC Hist. *See* External Tests

ADC Lin. *See* Internal Tests

ADC Linearity, Correction Constants, 5–15

ADC Ofs. *See* Internal Tests

ADC Ofs Cor. *See* Adjustment Tests

Adjustment Tests, 13–7

Adjustments
  Blanking, 5–26
  Display Position, 5–4
  Focus, 5–4
  Frequency Accuracy, 5–21
  Low Band Power Level, 5–25
  Power, 5–24
  Reference Assembly VCO Tune, 5–19

Air Flow Detector, 15–4

Air Flow Restricted: Check Fan Filter. *See* Power Supply Troubleshooting

Airlines, Connecting, 4–32

ALC On Off Softkey, 13–13

ALC/Signal Separation, 10–11

ALL INT. *See* Internal Tests

ALTER, 13–24

ANA[D]. *See* Analog Bus Codes

Analog Bus
Codes, 13–23
Correction Constant, 5–13
Description, 13–15
Nodes, 13–16
Analog Bus Menu, 13–15
Assembly Substitution, Fault Isolation, 12–5
Automatic Leveling Control, (ALC), 15–14
Aux Input, 3–6
Auxiliary Voltage Input, 3–6

B

Band–Related Problems, 10–10
Bias Connect, 3–6
Bias Tees, A60/A61, Replacement, 17–18
Blanking Adj. *See* Adjustment Tests
Blanking Adjustment, 5–26
Block Diagram, Overall, 6–5
Broadband Phase Lock, Problems, 10–4
Broadband Power, Problems, 10–11

C

Cable Check, 4–6
Cable Magnitude and Phase Stability, 4–9
Cable Substitution, 4–23
Cable Test, 12–6
Cables
Connector Repeatability, 4–9
Insertion Loss, 4–7
Magnitude and Phase Statility, 4–8
Return Loss, 4–6
Cal Coef 1–12. *See* Sys Ver Tests
Cal Factor Approximation, 4–12
Cal Kit Def. *See* Adjustment Tests
Cal Kit Defaults, Correction Constants, 5–28
Calibration
Cycle, 4–18, 4–24
Measurement, 4–1, 4–26
Calibration Coefficients, 2–1, 14–3
Terms, 14–3
Tests, 14–3
Calibration Kit, 4–2
2.4 mm, 1–3
Substitution, 4–23
Calibration Procedure, 14–2
Catastrophic Failure, 4–12
Characteristics
2.92 mm System, 3–81
General, 3–5
Operating, 4–2
Supplemental, 3–8
Check, Operational, 4–3
CMOS, 13–24
CMOS RAM, 15–7
See also Internal Tests
Color Purity, 5–6
Comparison Calculation, 4–35
Compatible Monitors, 3–7
Components, System, 4–2
Connecting Device, 4–28
Connection Techniques, 14–2
Connector Repeatability, 4–10
Connector Type, 4–2
Connectors, 14–2
Inspecting, Cleaning, Gaging, 4–5
Rear Panel, 3–6
Controllers, Troubleshooting, 6–4
Correction Constants
ADC Linearity, 5–15
Analog Bus, 5–13
Cal Kit Defaults, 5–28
IF Amplifier, 5–14
Option Numbers, 5–11
Power Linearity, 5–27
Retrieving Data from EEPROM Backup Disk, 5–18
Serial Number, 5–10
Source Pretune, 5–16
Storing to EEPROM Backup Disk, 5–17
Cover Removal, 5–2, 17–1
CPU
A9, 15–7
Main, 15–7
CPU – GSP Communication, 9–7
Crosstalk, 4–47
See also Errors, Systematic
CRT, Cleaning, 2–4
Crystal Reference Frequencies, 15–12

D

Data Trace, Normalizing, 4–9
DC Bias Tees, A60 and A61, 15–15
Dead Instrument, 4–16
Degaussing, 5–6
Demagnetizing. *See* Degaussing
Device Characterization
For HP 8510, 4–35
For HP 8722, 4–35
Diagnostic Tests, Internal, 9–3

Diagnostics, Internal, 13–1
DIF Control. *See* Internal Tests
DIF Counter. *See* Internal Tests
Digital Control, 15–2
  Block Diagram (Simplified), 15–6
  Theory, 15–5
  Troubleshooting, 7–2, 9–1
  A9 CPU Check, 9–2
  Abus Failure, 9–1
  Diagnostic Checks, 9–3
  Fatal Errors, 9–1
  Front Panel Control Check, 9–3
  HP–IB Failures, 9–1
Digital Control Signals, A14–to–A13, 10–8
Digital IF, A10, 13–16, 15–17
Digital Supply, +5V, 15–4
Directional Coupler, 11–3
Directional Couplers
  A62 A63, Replacement, 17–15
  A62 and A63, 15–15
Directivity
  See also Errors, Systematic
  EDF and EDR, 14–5
Disk Drive, 1–3
Disp 2 Ex. *See* Adjustment Tests
Disp/cpu com. *See* Display Tests
Display, 8–6, 8–8
  A18, Replacing, 17–6
  Color, 15–8
  Degaussing (Demagnetizing), 5–6
  Intensity Adjustments, 5–7
  Background, 5–7
  Maximum Intensity, 5–8
  Operating Default, 5–9
  Power Supply Troubleshooting, 9–6
  Test 55, 9–7
  Tests, 9–8
  Troubleshooting, 9–5
Display Blank, 4–16
Display Position Adjustment, 5–4
Display Power, Troubleshooting, 8–9
Display Tests, 13–8
Dissassembly Tools, 17–3
Divide–by–N Circuit, A14, 10–8
DRAM, 13–24
DRAM cell. *See* Display Tests
Drift Errors, Sources of, 4–42
DSP ALU. *See* Internal Tests
DSP Control. *See* Internal Tests
DSP Intrpt. *See* Internal Tests
DSP RAM. *See* Internal Tests
DSP Wr/Rd. *See* Internal Tests
DVM, 1–3
Dynamic Accuracy, 4–45, 4–47
Dynamic Range, For Transmission Measurements, 3–8
Dynamic Range Check, 4–13, 4–14

E

EEPROM, 15–7
EEPROM Backup Disk Procedure, 5–17
Environmental Check, 4–5
Equations
  Reflection Uncertainty, 4–43
  Transmission Uncertainty, 4–44
Error Correction, 4–1, 14–1
Error Messages
  Phase Lock, 10–1
  Power Supply, 8–3
Error Terms, 2–1, **14–1**
  Checking, 2–1
  Combining, 4–47
  Components Related to, 12–3
  Descriptions, 14–4
  Directivity, 14–5
  Inspection, 14–3
  Isolation, 14–8
  Load Match, 14–9
  Plotting, 2–2
  Reflection Tracking, 14–7
  Source Match, 14–6
  Transmission Tracking, 14–10
  Unusual, 12–4
Errors
  Drift, 4–3
  Fatal, 9–1
  Fatal, Troubleshooting, 9–5
  Measurement, 4–3
  Random, 4–3, 4–20
  Systematic, 4–3, 4–20
Ext AM, 3–6
Ext Mon, 3–6
Ext Ref In, 3–6
Ext Trigger, 3–6
External AM Input, 3–6
External Frequency Reference Input, 3–6
External Tests, 13–6
External Trigger Input, 3–6

F

Fan, 8–3, 8–6
  Troubleshooting, 8–8

Fan Circuit, Variable, 15–4
Fan Filter, Cleaning, 2–3
Fan Off, 4–16
Fan Voltages
  A15, 8–9
  A8, 8–8
Fault Isolation
  Assembly Substitution, 12–5
  Time Domain, 12–4
Firmware Revision, 13–13
Firmware Revision Softkey, 13–13
Flashing LEDs, 8–1
FN Count. *See* Internal Tests
Focus Adjustment, 5–4, 5–5
Fr Pan Diag. *See* External Tests
Fr Pan Seq. *See* External Tests
Fr Pan Wr/Rd. *See* Internal Tests
Frac N Cont. *See* Internal Tests
Fractional–N
  A14 (Digital), 13–21
  Synthesizer, A14/A13, 15–10
Frequency Accuracy, Source, 4–2
Frequency Accuracy Adjustment, 5–21
Frequency Counter, 1–3, 13–16
Frequency Range and Accuracy, Performance Test, 4–19
Frequency Resolution, Effect of, 3–7
Front Panel
  A1, 15–7
  A56 Lower, Replacement, 17–15
  Control Check, 9–3
  Key Codes, 9–11
  Replacement, 17–4
Front Panel Keys, Representation of, 1–1
Front Panel Processor, A2, 15–7
Full Sweep, 15–11
Functional Group Assemblies, Required Equipment, 7–4
Functional Groups, 6–1, 15–2
  Digital Control, 15–2
  Power Supply, 15–2
  Receiver, 15–2
  Signal Separation, 15–2
  Source, 15–2

G

Gaging test port connectors, 12–1
Glass Filter
  Cleaning, 2–4
  Removing, 2–4

H

Hardcopy, Procedure, 14–4
Hardkeys, Representation of, 1–1
HP 8510, Device Characterization for, 4–35
HP 8722, Device Characterization for, 4–35
HP–IB
  Commands, 13–2
  Failures, 9–1
  Service Mnemonic Definitions, 13–22
  Troubleshooting, 6–3, 9–9
HP–IB Cable, 1–3

I

IF Amplifier, Correction Constants, 5–14
IF Step Cor. *See* Adjustment Tests
Init EEPROM. *See* Adjustment Tests
Initialization, 4–24
Input Path
  A, 14–4
  B, 14–4
Input Ports Menu, 13–14
Insertion Loss, of Cables, 4–7
Instrument States, 4–17
Inten DAC. *See* Display Tests
Intensity Adjustments, Display, 5–7
Intensity Cor. *See* Adjustment Tests
Interface Power Supplies, A51, 10–12
Internal Diagnostic Checks, 9–3
Internal Diagnostic Tests, 9–4
Internal Tests, 13–4
Internal Transfer Switch, 4–17
IO Interconnect, 3–6
Isolate Faulty Group, 7–1
  Worksheet, 7–5
Isolation, 14–2
  (Crosstalk, EXF and EXR), 14–8
Isolation (Crosstalk). *See* Errors, Systematic

K

K Connector, 85056K, 3–81
Key Codes, Front Panel, 9–11
Keyword Label, Location of, 5–11
Kit Re–Certification, 4–20

L

LED State Definitions, 8–1
LEDs
  A8, 8–3, 8–7
  Code Sum, 9–2
  Flashing, 8–1
  Green and Red, 15–4
Light Occluder, 1–4
Line Power Module, 15–3
LO Signal
  1st, 15–16
  2nd, 15–17
Load Match
  See also Errors, Systematic (ELF and ELR), 14–9
Loads and Traces, 8–8
Low Band, A53, Replacement, 17–21
Low Band Power Level Adjustment, 5–25
Lower Box Assemblies, 8–7
Lower Front Panel Assembly, A56, 15–15

M

M/A/D/S, 14–4
M/A/D/S microcircuit, 5–25
M/A/D/S Microcircuit, A58, Replacement, 17–23
M/D/S, 14–4
M/D/S microcircuit, 5–25
M/D/S Microcircuit, A58, Replacement, 17–23
Magnitude, of Cables, 4–8
Main DRAM. *See* Internal Tests
Main VRAM. *See* Display Tests
Marginal Failures, 4–12
Measurement
  Errors, 4–3
  Process, 4–2
  Traceability, 4–21
Measurement Calibration, 4–1, 4–26
  Errors, 4–2
  Quality, 4–2
Measurement Errors
  Additional, 4–42
  Sources of, 4–40
Measurement Througput Summary, 3–5
Measurement Times, Typical, 3–5
Measurement Uncertainties, 4–2, 4–40
  Comparing, 4–36
Measurement Uncertainty
  Equations, 4–42
  HP 85050B Calibration Kit, 3–54
  HP 85050D Calibration Kit, 3–45
  HP 85052B Calibration Kit, 3–36
  HP 85052D Calibration Kit, 3–27
  HP 85054B Calibration Kit, 3–72
  HP 85054D Calibration Kit, 3–63
  HP 85056A Calibration Kit, 3–9, 3–18
  HP 85056K Calibration Kit, 3–81
Measurements, Not Repeatable, 4–17
Microwave Switch, S2/S3, Replacement, 17–27
Mismatches, 12–4
Modulator, Detector, Splitter, (M/D/S), 15–14

N

National Institute of Standards Technology, 4–21
  Traceability Path, 4–22
Noise Floor, 4–47
Non–HP Cables, 4–23
NORMAL, 13–24

O

OP CHECK, 4–3
Op Ck Port 1. *See* External Tests
OP CK PORT 1, 2, 4–15
Op Ck Port 2. *See* External Tests
Open Loop Power, 10–4
Operation, Theory of, 15–1
Operational Check, 4–3
Operational Check Procedures, 4–5
Operator's Check, 4–15
Option 003, Activation, 5–12
Option Cor. *See* Adjustment Tests
Option Numbers, Correction Constant, 5–11
Ordering Information, 16–2
Oscilloscope, 1–3
OUTPCNTR. *See* Analog Bus Codes
OUTPERRO. *See* Analog Bus Codes
OUTPTESS. *See* Analog Bus Codes
Overall Block Diagram, 6–5

P

Part Numbers, Power Cable and Plug, 16–5
Patterns, Test, 13–8
Peek/Poke Menu, 13–13
Performance
  System, 4–1
  Uncorrected, 3–2, 14–4
  Without Accuracy Enhancement, 3–2

Performance Parameters, Non–Warranted, 3–8
Performance Tests, 4–3, 4–18
  Frequency Range and Accuracy, 4–19
  Power Level, 4–11
  Tools, 4–18
Performance Verification, 4–18
Peripherals, Troubleshooting, 6–3
Phase Lock, A11, 13–17
  Comparing Phase and Frequency, 15–11
Phase Lock Error, 4–17
Phase Locked Sweep, 15–11
Phase Stability, of Cables, 4–8
Photometer, 1–4
Photometer Probe, 1–4
Post Reg. *See* Internal Tests
Post–Regulator, A8, 8–6, 15–4
Post–Repair Procedures, 18–1
Power Adj. *See* Adjustment Tests
Power Adjustments, 5–24
Power Level, Performance Test, 4–11
Power Linearity, Correction Constants, 5–27
Power Meter, 1–3
Power Range, 3–4
Power Sensor, 1–3
Power Supplies, A51 Interface, 10–13
Power Supply, 15–2
  Theory, 15–3
  Troubleshooting, 7–1, 8–1
  A15 Preregulator and Loads, 8–1
  A8 Post–regulator and Loads, 8–1
  Error Messages, 8–3
  Fan, 8–3, 8–8
  Flowchart, 8–2
Power Supply Hot. *See* Power Supply Troubleshooting
Power Supply Shut Down!. *See* Power Supply Troubleshooting
Power Sweep, 3–4
Preregulated Voltages, 15–3
Preregulator, A15, 8–3
  Replacement, 17–8
Preset. *See* Internal Tests
Pretune Adj. *See* Adjustment Tests
Preventive Maintenance, 2–1, 14–1
Printer, 1–3
Printer/Plotter, 4–17
Pulse Generator, A52, 10–9, 15–10
  Replacement, 17–32

R

R Sampler, A64, 15–10
R Signal Path, Faulty, 11–5
RAM, Main, 15–7
Random Errors, Sources of, 4–41
Range, Dynamic, For Transmission Measurements, 3–8
Rear Panel
  See also Internal Tests
  A16, 15–8
  Replacement, 17–8
Rear Panel Connectors, 3–6
Rebuilt–Exchange Assemblies, 16–1
Receiver, 15–2
  Assemblies and Associated Paths, 11–1
  Block Diagram (Simplified), 15–16
  Theory, 15–15
  Troubleshooting, 7–3, 11–1
Reference, A12, 13–20
Reference Assembly VCO Tune Adjustment, 5–19
Reference Designations, 16–3
Reflection, 14–2
Reflection Frequency Tracking. *See* Errors, Systematic
Reflection Magnitude Uncertainty, Total, 4–43
Reflection Phase Uncertainty, 4–44
Reflection Tracking, ERF and ERR, 14–7
Reflection Uncertainty Equations, 4–43
Repeatability, Cable Connector, 4–9
Repeatability Values, 2–3
Replaceable Parts, 16–1
Replacement Procedures, 17–1
Result, Measurement, 4–21
Return Loss, of Cables, 4–6
RF Cable Set, 1–3
RF Path, Isolate the Fault in, 12–4
RGB outputs. *See* Display Tests
Ribbon Cable, 9–7
ROM, 15–7
  See also Internal Tests
ROM/RAM Tests, 13–24
Rotary Pulse Generator
  Reassembling, 17–4
  Removing, 17–4
  Replacement, 17–4

S

S–parameter Values, 4–47

Sampler, A64/A65/A66, Replacement, 17–12
Sampler Check, 5–22
  A Sampler, 5–22
  B Sampler, 5–22
  R Sampler, 5–23
Sampler Voltage, 11–4
Samplers, 15–16
  A64/A65/A66, 15–16
Scale and Repeatability Values, 2–3
Second Converters, 15–16
  A4/A5/A6, 15–17
Self Diagnose Softkey, 13–4
Self Test Fail, 4–17
Serial Cor. *See* Adjustment Tests
Serial Number, Correction Constant, 5–10
Service and Equipment Overview, 1–1
Service Key Menus, 13–1
Service Manual, Organization of, 1–1
Service Modes, Menu, 13–10, 13–11
Service Modes More Menu, 13–12
Shorts and Opens, Verifying, 12–6
Shutdown Circuit, 15–4
Shutdown Disable, 8–8
Shutdown Indications, Green and Red LEDs, 15–4
Signal Processor, Digital, 15–8
Signal Separation, 15–2, 15–14
  Block Diagram (Simplified), 15–14
Signals, Down–Converting, 15–10
SKIP, 13–24
Softkey Initiated Tests, 4–15
Softkeys, Representation of, 1–1
Source, 15–2
  Troubleshooting, 7–2, 10–1
  Flowchart, 10–2
Source Block
  Simplified Diagram, 15–13
  YIG Oscillator Signals, 15–12
Source Frequency Accuracy, 4–2
Source Group
  Block Diagram (Simplified), 15–9
  Theory, 15–9
Source Interface, A59, Replacement, 17–29
Source Match
  See also Errors, Systematic
  ESF and ESR, 14–6
Source Power Specifications, 3–4
Source Pretune, 15–10
  Correction Constants, 5–16
Source Specifications, 3–3
Specifications, 3–1
  2.4 mm System, 3–9
  3.5 mm System, 3–27
  7 mm, 3–45
  Source, 3–3
  Source Power, 3–4
  Type–N, 3–63
SRC Tune Menu, 13–12
Stability, Test Port Cable, 4–2
Step Attenuator, A69, 10–12, 15–15
Step Recovery Diode, 15–10
Stuck Key, 9–10
Subsweep Frequencies, 15–12
Supplemental Characteristics, 3–8
Sweep Trig. *See* Internal Tests
Switch Repeatability, 3–1
Symbol Conventions, 13–23
Sys Ver Init. *See* Sys Ver Tests
Sys Ver Tests, 13–6
System
  Block Diagram, Simplified, 15–1
  Components, 4–2
  Operation, 15–1
  Performance Verification, 4–3
System Components, Significant, 14–5, 14–6, 14–7, 14–8, 14–9, 14–10
System Configurations, 4–23
System Failure, 6–1
System Measurement Uncertainties, Comparing for Performance Verification Devices, 4–35
System Performance, Determining Expected, 4–46
System Performance and Verification, 4–1
System Performance Verification, 4–3
System Verification, 4–27
Systematic Errors, 14–2
  Sources of, 4–40

T

Tabs, 1–1
Temperature Check, 4–5
Test, Options Menu, 13–3
Test 21 Op Ck Port 1, 2, 4–15
Test Equipment, Service, 1–3
Test Number, 4–28
Test Patterns, 13–8
Test Port Connectors
  Gaging, 12–1

J1/J2, Replacement, 17–15
Test Set Interface, A51, 15–8
Replacement, 17–20
Test Status Codes, 4–25
Tests
Adjustment, 13–7
Descriptions, 13–4
Display, 13–8
External, 13–6
Internal, 13–4
OP CHECK, 4–3
Remotely Invoking, 13–22
ROM/RAM, 13–24
Status Terms, 13–3
Sys Ver, 13–6
Tests Menu, 13–2
Time Domain, Fault Isolation, 12–4
Tool Kit, 1–3
Total System Performance Test, Record, 4–54, 4–56, 4–58
Total System Uncertainty, 4–20
Total System Uncertainty Test, 4–3
Traceability
Measurement, 4–21
National Institute of Standards Technology, 4–21
Traceability Path, 4–21
Transfer Switch
Repeatability, 4–15
S4, 15–15
Replacement, 17–18
Transmission, 14–2
Transmission Frequency Tracking. *See* Errors, Systematic
Transmission Magnitude Uncertainty, 4–44
Transmission Phase Uncertainty, 4–45
Transmission Tracking, ETF and ETR, 14–10
Transmission Uncertainty Equations, 4–44
Troubleshooting, 6–1, 14–1
Accessories, 7–3, 12–1
Digital Control, 7–2, 9–1
A1/A2 Front Panel, 9–9
Fatal Error, 9–5
HP–IB Systems, 6–3
Power Supply, 7–1, 8–1
Receiver, 7–3, 11–1
Source, 7–2, 10–1
Strategy, 6–1
Systems with Controllers, 6–4
Systems with Multiple Peripherals, 6–3
TST?. *See* Analog Bus Codes
Turn On Sequence, 6–2
Typical Performance Parameters, 3–8

U

Uncertainty Limits, 4–20
Upper Box Assemblies, 8–7

V

VCO Exercise Matrix, 10–7
VCO Range Check Frequencies, 10–6
VCXO Adjustment Location, 5–21
Ver Dev 1. *See* Sys Ver Tests
Ver Dev 2. *See* Sys Ver Tests
Ver Dev 3. *See* Sys Ver Tests
Ver Dev 4. *See* Sys Ver Tests
Verification, System, 4–1, 4–27
Verification Data, Factory Measured, 4–20
Verification Device, 4–28
Verification Kit, 4–20
2.4 mm, 1–3
Verification Results, Interpreting, 4–38
Vertical Position Adjustment, 5–4
Voltage, Indications (Green LEDs), 15–4
Voltages
A8 Display, 8–9
Display Power Supply, Entering A19, 9–5
Fan, 8–8, 8–9
Lower Box Bias, 10–12
Test Point, 8–10
VRAM bank. *See* Display Tests
VRAM/video. *See* Display Tests

W

Walking One Pattern, 9–8
Warranty, Voiding of, 5–4

Y

YIG 1, A55, Replacement, 17–26
YIG Oscillator
Signals, 15–12
Tuning, 15–11

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MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

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Accessories returned with unit

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Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

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Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

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Observed symtoms/problems

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